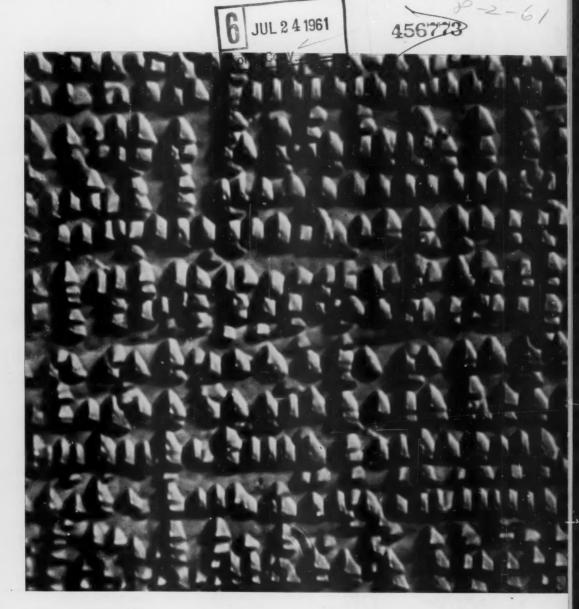
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Dislocations marked by etch pits in a deformed crystal of corundum (Al₂O₈). The same phenomenon is observed in deformed ice (about × 4000). See page 164. [Peter Gibbs, University of Utah; after W. D. Kingery, Introduction to Ceramics (Wiley, New York, 1960)]



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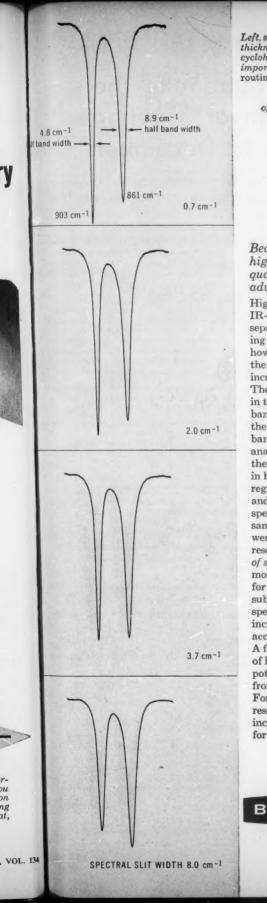
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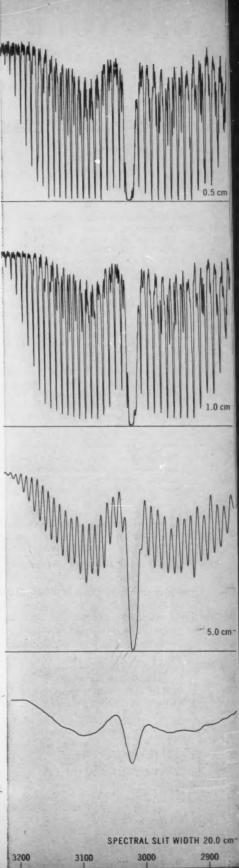
High resolution of the Beckman IR-7 does more than merely separate closely spaced neighboring bands. Note, for instance, how the apparent intensities of the two cyclohexane bands increase with higher resolution. The relatively greater increase in the intensity of the 903 cm⁻¹ band at higher resolutions is the result of its narrower halfband width. These two commonly analyzed samples demonstrate the importance of high resolution in both low and high frequency regions and, for both gas and liquid samples. Comparative spectra were run with identical samples; slit width and resolutions, were varied as noted. A High resolution is essential for all areas of spectroscopy; for studies of molecular motion and structure, for differentiating between substances which exhibit similar spectra, and also for providing increased sensitivity and absolute accuracy for quantitative analysis. A further long-run advantage of high resolution is the increased potential for transferring data from one instrument to another. For more information about high resolution spectrophotometers, including indene spectra, write for Data File 38-29-02

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- 2. The 29th John Wesley Powell Memorial Lecture. Speaker: Glenn T. Seaborg; Paul M. Gross, presiding.
- 3. On "AAAS Day," the four broad, interdisciplinary symposia—Physics of the Upper Atmosphere; Geochemical Evolution—The First Five Billion Years; Existing Levels of Radioactivity in Man and His Environment; and Water and Climate—arranged by AAAS Sections jointly.
- 4. The Special Sessions: AAAS Presidential Address and Reception; Joint Address of Sigma Xi and Phi Beta Kappa by Harrison Brown; the Tau Beta Pi Address; National Geographic Society Illustrated Lecture; and the second George Sarton Memorial Lecture.
- The programs of all 18 AAAS Sections (specialized symposia and contributed papers).
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- Beta Beta Beta Biological Society, Biometric Society (WNAR), National Association of Biology Teachers, Scientific Research Society of America, Society for General Systems Research, Society of Protozoologists, Society of Systematic Zoology, and the Society of the Sigma Xi.
- 7. The multi-sessioned special programs of the American Association of Clinical Chemists, American Astronautical Society, American Meteorological Society, American Physiological Society, American Psychiatric Association, Association of American Geographers, Ecological Society of America, National Science Teachers Association, National Speleological Society—and still others, a total of some 70 to 80 participating organizations.
- The sessions of the Academy Conference, the Conference ence on Scientific Communication, and the Conference on Scientific Manpower.
- The sessions of the AAAS Cooperative Committee on the Teaching of Science and Mathematics, of the AAAS Committee on Science in the Promotion of Human Welfare, and of the Committee on Public Understanding of Science.
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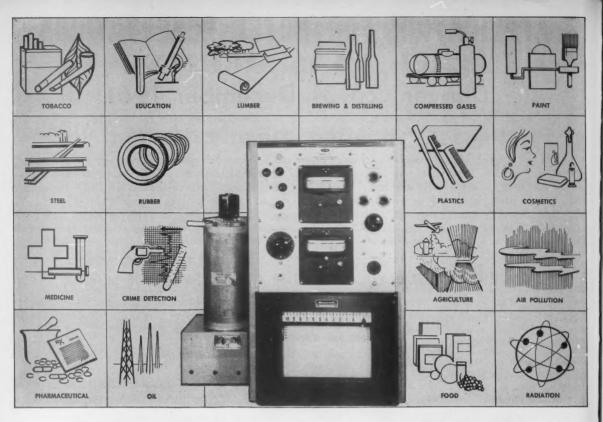
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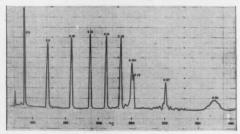
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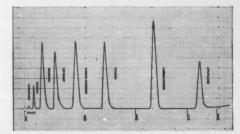
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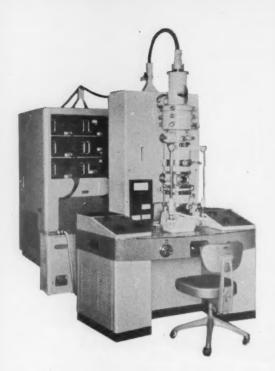
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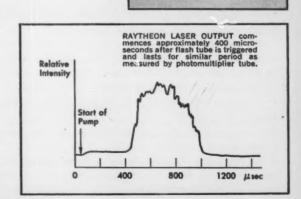
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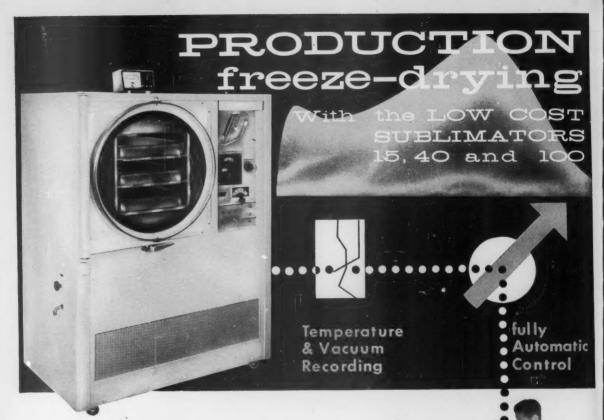
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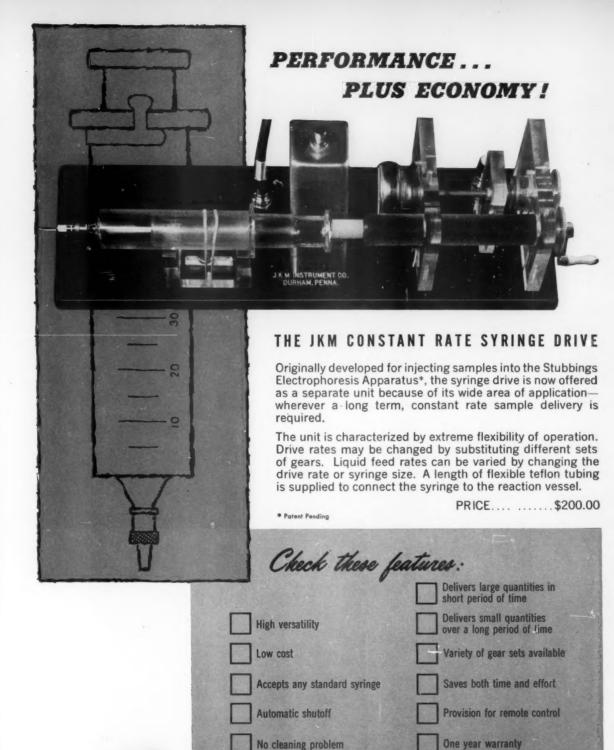
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Additional card on page 221

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	32	31			COVER 4	Cover 3	230	235	234,01	234,0	233,0	233,1	732,1	232,0	231,1	

READERS' SERVICE

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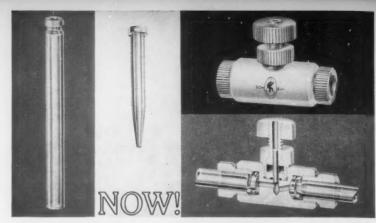
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Room 1740

New York 36, New York



Teflon* Needle Valves** with Rubber "O" Rings control flow of corrosive fluids-even under high vacuum!

At last, a needle valve that solves the problem of delicate control of flow of highly corrosive fluids, even under high vacuum! No chance of breakage or contamination—fluids touch only acid-and-alkali-resistant glass, teflon, and diamonite***

Developed by the Manostat Corporation, this new needle valve incorporates 4 important improvements over previously available valves.

- 1 All plastic parts not in contact with fluid are made from highly corrosion resistant polypropylene that will withstand autoclaving temperatures.
- 2 Rubber "O" rings, situated so as not to come in contact with the fluid, assure high vacuum seals from the surroundings.
- 3 Connecting tubes are of heavy wall pyrex brand glass for added mechanical strength.
- 4 Needle is a sintered synthetic ruby—diamonite—stronger and more corrosion resistant than glass, especially against strong alkali.

PRICE LIST

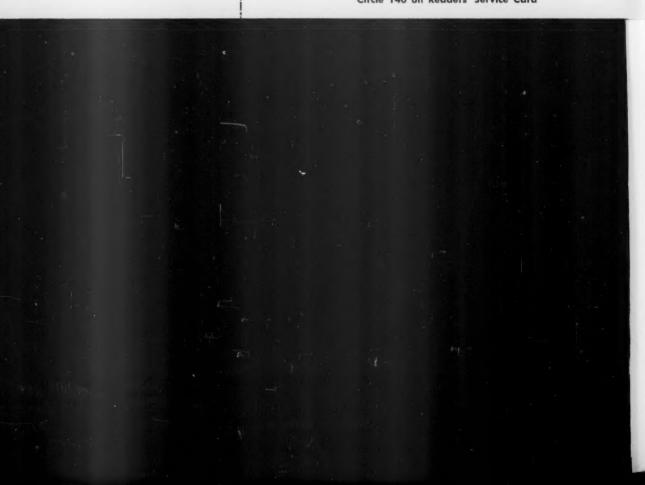
Cat. No. G10428T—Toficn Needle Valve ready for use with directions but ne glass parts. . . . 6.83

Cat. No. 83118C - Buret tip. .70 *Trade name for DuPont Polytetrafluorethylene

Patent applied for *Trade name for sintered corundum

The EMIL GREINER Co.
Dopt. 427, 20-28 N. Hoore St. N. Y. 13, N. Y.

Circle 140 on Readers' Service Card





The SARGENT Model XV RECORDING POLAROGRAPH®



offers you-

- **ULL 10 INCH** CHART
- 1/10% ACCURACY OF MEASUREMENT

TEN STANDARDIZED POLARIZING RANGES

This new Sargent POLAROGRAPH gives you a large 250 mm (10 inches) chart and the highest accuracy and current sensitivity at the lowest price of any pen writing polarographic instrument on the market.

It offers you optimum specifications based on over twenty years of leadership in design, manufacture and service in this specialized field of analysis.

The polarographic method is capable of reproducibility to 1/10% and analytical accuracy to ½%. To make use of this facility, the instrument must be accurate to 1/10% and chart space must be provided for recording large steps to achieve measuring precision. We strongly advise against the purchase of any polarographic instrument using miniature (5 inch) charts and low gain balancing systems in the 1% order of precision.

This Model XV is adaptable to 10-6 M determinations with the S-29315 Micro Range Extender.

®Registered Trade Mark (Pat. No. 2,931,964)

19, from .003 to 1.0 µA/mm. **Current Ranges:**

0 to -1; -1 to -2; -2 to -3; -3 to -4; +.5 to -5; 0 to -2; -2 to -4, +1 to -1; 0 to -3; +1.5 to -1.5.Polarizing Ranges, standard, 10 seconds; 1 second or 4 seconds optional. **Balancing Speed:** Bridge Drive: synchronous, continuous repeating, reversible; rotation time, 10 minutes.

current axis, 250 mm; voltage axis, 10 inches equals one bridge revolution.

Current Accuracy: Voltage Accuracy: Chart Drive:

volts:

Chart Scale:

synchronous, 1 inch per minute standard; other speeds **Writing Plate:**

1/10%

1/4 %

bottoma. $10\frac{1}{2} \times 12\frac{1}{2}$ inches; angle of slope, 30°. manual against internal cadmium sulfate standard cell for both current and voltage. Standardization:

Damping: RC, four stage. Suppression:

ball point; Leroy type optional. zero displacement control, mercury cell powered, 6 times chart width, upscale or downscale.

Potentiometric Range: Finish:

2.5 millivolts, usable as general potentiometric recorder, case, enameled steel; panels, anodized aluminum; writing plate, polished stainless steel; knobs and dials, chromium plated and buffed. 23 x 17 x 10.

Dimensions: **Net Weight:** 65 pounds.

Catalog number \$-29310 with accessories and supplies. . . . \$1585.00

For complete information write for Sargent Bulletin P

SARGENT SCIENTIFIC LABORATORY INSTRUMENTS • APPARATUS • SUPPLIES • CHEMICALS

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TORSION DIAL BALANCES with WEIGHT LOADERS



Torsion's new line of weight-loading dial balances retains all the proved advantages of the unique Torsion principle which eliminates knife edges and guarantees long-lasting accuracy.

Since Torsion introduced the "fine weighing" dial over a year ago, users have reported substantial savings in weighing time. Now Torsion has added a "weight-loading" dial which enables the user to "dial in" additional weights as described in the specifications for each new balance.

Both dials can be used without arresting the balance.

By using two dials, one for weight loading and one for fine weighing, Torsion has cut weighing time even more.

With Torsion's new two-dial feature, the time-consuming handling of small, loose weights has been eliminated. In addition to faster weighing, Torsion's new dial balances with weight loaders minimize the possibility of weights becoming inaccurate from rough handling.

Ask your laboratory supply salesman for a demonstration or write for complete specifications.

The Torsion Balance Company

Main Office and Factory: Clifton, New Jersey Sales Offices: Chi., Ill., San Mateo, Cal.

- A TORSION MODEL DWL-3
 Capacity: 200 grams
 Weight-loading Dial: up to 9
 grams by 1 gram increments
 Fine Weighing Dial: 1 gram by
 .02 gram graduations
 (Readability: .005 g)
- B TORSION DWL-5
 Capacity: 500 grams
 Weight-loading Dial: up to 90
 grams by 10 gram increments
 Fine Weighing Dial: 10 grams by
 .1 gram graduations
 (Readability: .02 g)
- C TORSION DWL-2
 Capacity: 120 grams
 Weight-loading Dial: up to 9
 grams by 1 gram increments
 Fine Weighing Dial: 1 gram by
 .01 gram graduations
 (Readability: .002 g)

TORSION DWL2-1
Specifications are same as the DWL-2
except that this model has scoop
for seeds or other bulky material.

VOL. 134

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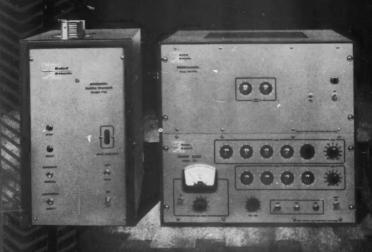
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Baird-Atomic introduces a new AUTOMATIC SAMPLE CHANGING SYSTEM





This simplified system incorporates the latest techniques and instrumentation for automatic detection, timing, counting and data presentation. It accommodates up to 35 samples, processes and records results including sample number, time, count and, on request, count rate. The overriding time and count functions are performed by the new B/A Model 135 Scaler Timer.

Heart of the new B/A System is the Model 755 sample changer that assures positive, jam-proof operation because of its simple casted construction. It is specifically designed for geiger or proportional counting but its flexible detector mount-

ing permits the use of scintillation probes for gamma counting.

For complete details, call or write your nearest B/A representative today.

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1. Graduated PYREX beaker—Now you can measure volumes quickly and with reasonable accuracy in a multi-use beaker. Graduations are white enamel. Cost is only a few pennies more than for ungraduated beaker. 250, 400, 600, 800, 1000 ml. No. 1002.



2. ACCU-RED cylinder—Graduations will never fade or wear off this PYREX cylinder. ACCU-RED process fuses them right into the glass, as in our ACCU-RED pipets and burets. Bead and hex bottom help prevent breakage. 10, 25, 50, 100, 250 ml. No. 3050.



3. Replaceable tubulation—You don't have to throw out this PYREX filter flask if the tubulation breaks. Tubulation and neoprene grommet both are easily, inexpensively replaced. 250, 500, 1000 ml. No. 5341.



4. Bigger funnels — Now you can match the Pyrex filling funnel diameter to the job. New inside diameters are 75, 100, 125, and 150 mm.—added to the 65 mm. size in LG-2. No. 6220.

FIVE NEW LABWARE TOOLS FROM CORNING

These five products are the latest results of our continuing effort to help you do a job better, do it more quickly, and save money.

Four of them give you the time-proved chemical-thermal-mechanical balance of Pyrex® brand No. 7740 glass. You can work confidently, relying on its combination of properties.

The fifth has a Vycor® brand glass jacket to provide the extreme resistance to thermal shock and the chemical durability an immersion heater requires. You can use it for fast heating of most acids and other liquids.

For more information on any or all of these items, write for Supplement No. 3 to Catalog LG-2. Or call your laboratory



5. VYCOR immersion heater—You can swizzle heat into a solution quickly with this radiant heater. Cord-end portion is unheated so you can hold it or rest it against the container. Cord and plug included. 250, 500, 1000 watts—all operate on 120 volts. No. 16790.

supply representative. When ordering, combine your Pyrex labware needs for quantity discounts as high as 23.5%.

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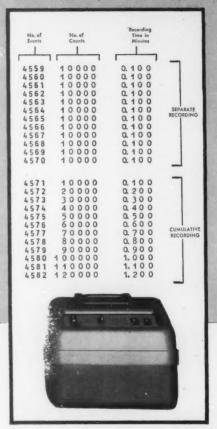
X-RAY DIFFRACTION AND SPECTROSCOPY



AUTOMATIC PRINTER another time-saving device from RCA

This new RCA Printer automatically records events, counts, and time, thus freeing the researcher for other duties while this information is being accumulated. It also provides an accurate and convenient means of checking the stability of the counting, timing and recording circuits—a valuable advantage for spectroscopists in quantitative work and for diffractionists in line profile studies. The unit can be used with scintillation, proportional and Geiger-Mueller counter tubes in conjunction with the RCA Electronic Circuit Panel.

The Printer is the latest addition to the wide range of attachments and accessories available for RCA X-Ray Diffraction and Spectroscopy apparatus which contribute to its outstanding flexibility.



Others include an X-Ray Vacuum Spectrometer for analysis of both light and heavy elements, a versatile horizontal goniometer which, with RCA accessories, performs six functions, and a Table Model Generator, available complete with cameras, for as little as \$4000.

Installation supervision and contract service are available through the RCA Service Company.

Leasing Plan

RCA X-ray diffraction and spectroscopy equipment, as well as electron microscopes, can be leased directly from RCA, with no down payment, low monthly rates and a favorable option to buy.

For details on RCA's complete line of X-Ray Diffraction and Spectroscopy apparatus or Electron Microscopes, write to RCA, Dept. XC-362, Bldg. 15-1, Camden, N. J.



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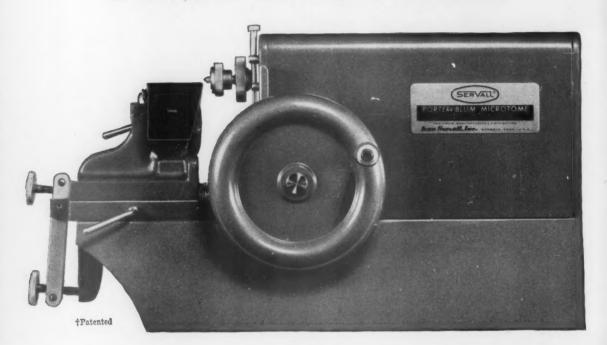




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"Porter-Blum" ULTRA-MICROTOME



ALSO CUTS COSTS!

The "Porter-Blum" is the inexpensive precision instrument for electron- and light-microscope preparations. This ultra-microtome, known as "the standard in its field," will cut serial sections, or alternate thin and thick sections, of the highest uniformity and at the lowest possible cost. Its purchase price is below what you would expect to pay for an instrument of this quality, and its renowned trouble-free operation keeps maintenance costs to a minimum even under constant use.

The "Porter-Blum" will section a wide range of difficult materials such as bone, teeth, soft metals, plastics, fibers, hard rubber, etc., as well as all types of biological and plant tissues. Fingertip control permits "dialing" required thicknesses from 1/2 to 1/40 micron. The unique "by-pass" feature enables the operator to cut sections thicker than 1/2 micron when desired. Before you purchase any ultra-microtome, investigate the quality and economy available with the "Porter-Blum."

Please ask us for Bulletin SC-7MT

Ivan Sorvall, Inc.

148

SCIENCE, VOL. 134

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"MASTER CLOCK"

for the missile range uses 15 Honeywell Visicorder oscillographs

The Timing Operations Center designed and built by Epsco-West for the Navy's Pacific Missile Range is now in use at Point Mugu, California. It makes use of 15 Honeywell Visicorders to read out (as shown on the unretouched record at left) the modulated timing codes distributed as balanced outputs to the Center's "customers."

The solid-state Epsco-West TOC generates up to 11 separate timing signals, one or all of which may be delivered to any of 36 users.

The 906B Visicorder also performs a supplementary function as a monitor on the timing and test-patch panel, and as permanent "record-keeper" for the built-in indicators and test oscilloscopes. Visicorders were selected for their jobs with the TOC because of their versatility, reliability, low cost, and compact size ((10" x 10" x 151/2"; weight,

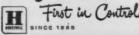
Pioneer and acknowledged standard in the field of high frequency direct-recording oscillography, the Visicorder is available in several models, from 6 to 36 channels, DC to 5000 cps response, up to 50,000"/sec writing speed. Honeywell engineering is at your service through 120 field offices for help in applying one Visicorder or a full system to your data acquisition program; or a quantity of Visicorders for OEM application in your products.



Call your local Honeywell office now or write today for Catalogs HC906B, 1012, 1108, and 1406 to Minneapolis-Honeywell, Heiland Division, 5200 East Evans Avenue, Denver 22, Colorado. Our telephone is SKyline 6-3681, Area Code 303.

Honeywell

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ord speed changed during recording.

actual size.

NIKON model 6 OPTICAL COMPARATOR

for fast, accurate evaluation of ultracentrifuge photo plates

A major pharmaceutical manufacturer recently investigated the use of a Nikon 6 Optical Comparator for measuring and analyzing ultracentrifuge photo plates. The performance was so impressive, the unit was immediately purchased and added to the company's instrumentation facilities. The news travelled.

Within less than a month, a Nikon 6 Comparator was acquired by a large hospital, and shortly thereafter, by several other hospitals and by a food research laboratory. The Comparator, in each instance, demonstrated a marked superiority over equipment previously used—greater speed and convenience, and greater accuracy.

The Nikon 6 Cptical Comparator is essentially a macro projector with a magnification range from 10x to 100x—extendable to 500x. Any object, thing, substance, specimen, photo plate or slide placed upon the stage, appears on its 12" screen as a sharp, bright, magni-

fied image, which can be observed by many people simultaneously—studied, evaluated and precisely measured. And all of this can be done comfortably in a normally lit room. The Model 6 Comparator is provided with surface as well as sub-stage illumination.

New laboratory applications for the Nikon 6 Comparator are being constantly reported. In addition to the analysis of ultracentrifuge data, its use has been extended to many phases of chromatography, evaluating fringe patterns and reading electrophoresis photo plates and cells.

You may have an inspection or measurement problem which lends itself to the unique capabilities of the Nikon 6 Optical Comparator. Why not tell us about it. Write to Dept. S-7.



NIKON INC., INSTRUMENT DIVISION, 111 Fifth Ave., N. Y. 3, N. Y.



PRECISION SCIENTIFIC CO.



Yearly Review

Calendar of NEWLY INTRODUCED PRODUCTS 1960-1961

MAY 1960

New Heated Vacuum Dessicator

AUGUST 1960

RIG JACK LITTLE JACK



STURDY, DEPENDABLE LABORATORY JACKS

Big Jack raises or lowers heavy flasks, hot plates, baths, etc. up to 100 pounds - 3 to 12 inches.

Little Jack, a smaller model of Big Jack designed to work with small objects-lifts or lowers up to 10 pounds-11/2" to 5". Ideal for micro work. Write for Bulletin 611.

NOVEMBER 1960

Meters



Designed to afford increased pressure range . . . from 0.3 inches water pressure to 15 PSI. Self serviced by easy removal of the back cover. Housing is of heavy cast aluminum with epoxy coated interior. Construction throughout assures longer life. Write for Bulletin No. 612.

FEBRUARY 1961

DECEMBER 1960

A versatile lab utility-dries faster, main-

tains samples at desired temperatures,

evaporates solvent traces rapidly, does

double duty as a vacuum oven-get Bul-

letin 608 for complete details.

New Therm-O-Plate

Hot **Plates**



Do you want to Heat? -- Stir? -- Shake? Need up to 800°F? Then depend on Therm-O-Plate line. Four types-eleven sizes-standard models, stirring, heating, shaking, heating and explosion proof models. Get full details - send for Bulletin 609.

JANUARY 1961

Unique Pump Exchange



two single plans to reduce your vacuum pump problems, Interchangeable parts or rebuilt pumps always available from stock. Write for Bulletin 616.

Micro **Serological**



A truly versatile small bath-for micro work and exacting tests - occupies only 1/4 square foot-has range up to 100°Cuniformity ±0.2°C or better. Weighs only 5 lbs. Has new universal rack for simultaneous use of various sizes and shapes of tubes, flasks and beakers - has micro tube rack for 6 to 12 mm. tubes. Write for Bulletin 613.

MARCH 1961

Constant Temperature Controlled Agitation Shaker Baths



Complete new line-for Microbiological, Biochemical and Physio-Chemical studies. Variable speed control. Adjustable stroke length, Guaranteed temperature uniformity ±0.5°C. or better. Three sizes to meet all requirements. Write for Bulletin 614,

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A speedy reliable solution to routine gas and volatile liquid analysis problems... Quickly pays for itself in savings in time and materi-al ... Inexpensively makes gas chromatography avail-able to everyone.



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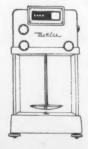
When we speak of balances for accurate weighing we are satisfied only with instruments having the highest precision and engineered to maintain this precision forever under constant hard use.

While it is true that such an ideal is not entirely attainable, people who use Mettler balances tell us we come amazingly close. Even so, we constantly strive for still more precise readings.

If you are hard to please in this respect, let's get together and work on your weighing problems.

There are now more than fifty balance models in the Mettler line. They cover all the needs of the modern laboratory. Capacity ranges from 8000 grams to two milligrams, and precision from one milligram to a fraction of one microgram. In addition to the now famous Mettler "B" and "H" balances, the "M5" micro and new "UM7" ultra micro are designed to fill the needs of those requiring highest accuracy in micro ranges.

We would like to demonstrate the best instrument for your application in your laboratory or plant. If you wish to evaluate the balance at your leisure, arrangements can be made to leave certain models on trial. Write today concerning your requirements and arrange a demonstration at your convenience.





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The AO Spencer Quebec Dark Field Colony Counter belongs to this "special" group. You'll find them as standard equipment in bacteriological and pharmaceutical labs, in research and control labs throughout the food processing, dairy and beverage industries, in Public Health departments ... wherever bacterial limits are used as a criteria in maintaining health or quality standards.

A unique illumination system floods the entire culture plate with soft, uniform light. The dark, contrasting background throws the colonies into bold relief... makes even pinpoint colonies easy to distinguish and count. And the sharp, controllable magnification reveals colony morphology for quick differential counts.

A Wolfthuegel Guide Plate is supplied as standard... counter also accommodates Stewart and Jeffers guide plate.

Complete information on the AO Spencer Dark Field Quebec Colony Counter is yours for the asking. Talk to your AO Representative or write us today.

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get details from your local Picker representative, or write Picker X-Ray Corporation, White Plains, New York

all these operating advantages

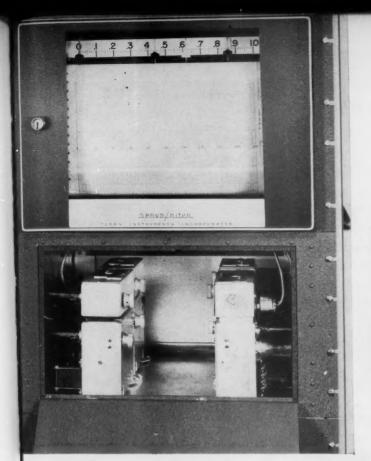
(because they're fully transistorized) greater operating stability greater long term stability no need for warm-up delay longer component life greater compactness easier circuit replacement more uniform production quality







no capital investment if you'd rather rent—ask about the PICKER RENTAL PLAN



NEW from TI

4-CHANNEL Dervo/riter: RECORDER



RECORDS 4 CONTINUOUS CHANNELS ON A VVIDE SINGLE CHART

You can now record four continuous channels of data on a wide single chart... four overlapping pens continuously recording on the full width of the 93/4" chart. For the first time in a potentiometric recorder four variables can be traced with high resolution on a single sheet of chart paper! The recorder is the proved servo/riter in the flush-mounting configuration for use in standard 19" relay racks.

Amplifiers are separate from the recorder

Amplifiers are separate from the recorder and may be mounted as far as 15 feet from the recorder chassis. An optional factory-assembled package places the four amplifiers in a standard rack-mounting case for location adjacent to the

recorder case.

In addition, five- and six-channel servo/riter recorders are available, utilizing overlapping pens on dual side-by-side $4\frac{1}{2}$ " charts. Two- and three-channel recorders are offered in both the narrow and wide configurations, with all pens writing on only one sheet of chart paper.

The same industry-proved performance characteristics and wide ranges of the single and dual-channel servo/riter recorders are designed into the new multi-channel instruments. These include:

- HIGH SENSITIVITY— 1.0 mv to 100 mv full-scale
- HIGH INPUT IMPEDANCE— 4 megohms off-balance
- FAST RESPONSE—
 .5 second full-scale rise time
- HIGH REJECTION RATIOS—

 "Transverse" 1,000/1

 "Longitudinal" 330/1
 d-c Common Mode 30,000/1
 d-c & a-c Guard 30,000,000/1
- HIGH RELIABILITY—Non-lash gearing and conservatively rated electronics.

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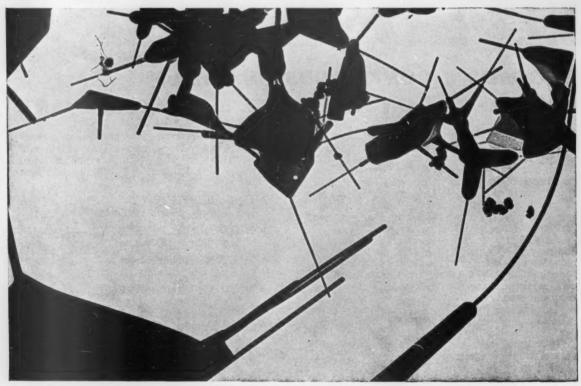
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HIGH-RESOLUTION, ALL-PURPOSE JEM-6A ELECTRON MICROSCOPE FROM FISHER

Now, Fisher Scientific is your exclusive United States and Canadian source for electron microscopes, related instruments manufactured by Japan Electron Optics Laboratory Co., Ltd. Model JEM-6A gives you resolving power up to 8 Angstroms for physical, chemical and metallurgical work... 12 A is routine. Direct magnification: continuously variable from 600X to 200,000X, providing photographic magnifications above 1,000,000X. Accelerating voltages of 50, 80 and 100 KV are extremely stable. With accessories, you heat specimens to 1000° C; cool them to -140° C; put them under tensile stress while inside the JEM-6A. A 16-mm camera films changes in crystal structure. You can record electron diffraction patterns of 1-micron fields . . . make direct-reflection photographs of surface structure. For full details, call your Fisher branch, or write Fisher Scientific Company, 139 Fisher Building, Pittsburgh 19, Pa.

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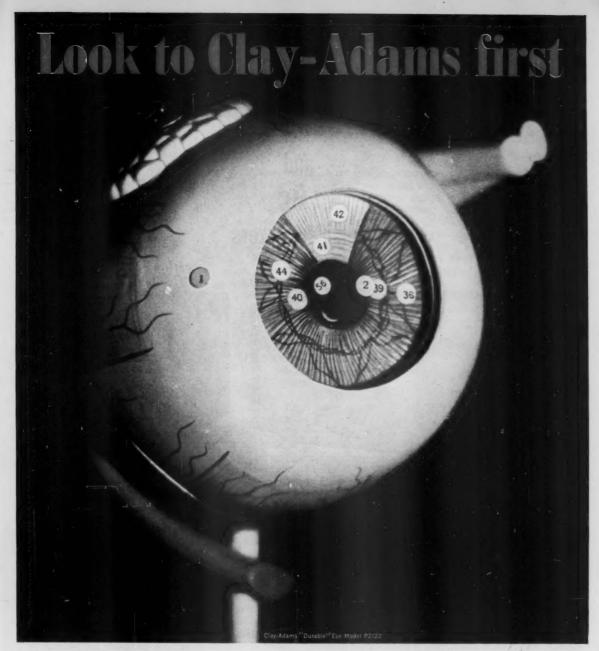
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The System

Universities are faced with some hard choices in the immediate future as a consequence of rapidly mounting enrollments of both undergraduate and graduate students. One of these choices involves undergraduate education. For, in contrast to liberal-arts and other 4-year colleges, universities attempt to carry on two conflicting activities: the education of undergraduates for all kinds of occupations and the furtherance of research by both faculty and graduate students.

A peculiarity in university organization is that there is in general little differentiation in faculty function: a faculty member typically teaches undergraduates, does research, and supervises graduate students. These tasks demand quite different talents. To arouse interest, to lay bare the bones of a subject without too much qualification, in short to make an art of teaching, are the requirements for the one task; to carry on research, to teach by example, and to give general guidance to students already well immersed in a subject are the requirements of the other.

It is true that here and there some division of labor has occurred. Some professors, usually called research professors, never deal with undergraduates, and some others devote all or almost all of their efforts to undergraduate teaching. But this differentiation is exceptional, and the question remains: Why have universities in general failed to differentiate faculty functions more sharply? Part of the explanation surely is to be sought in the implicit value systems of faculties and administrators. Research and the training of graduate students are valued highly by the faculty; teaching, by contrast, is second-class. Administrators, however, according to a recent study for the American Council on Education, rate teaching as highly important and indeed regard, or at least claim to regard, teaching ability as the single most important factor in judging the worth of faculty members. Despite this kind of assurance about the value of teaching, few university faculty members believe that time devoted to teaching will receive either recognition or reward. It is a more usual, and probably a more realistic, view that time taken for teaching is time stolen from research, and that the road to academic heaven is paved with publications.

These widely prevalent beliefs of faculty members have a baneful influence on the quality of undergraduate education. Those who make the decisions about promotions in universities might well consider the balanced appraisal made by Abraham Flexner in 1930: "Original thinkers and investigators do not . . . represent the only type of university professor. They will always be the distinguished figures; theirs will usually be the most profound and far-reaching influence. But even universities, modern universities, need and use men of a different stamp—teachers whose own contributions to learning are of less importance than their influence in stimulating students or their resourcefulness in bringing together the researches of others."

Since this statement was made, the emphasis on research has tipped the balance still further away from undergraduate education. The universities have two possible courses of action: they can become "senior" colleges and graduate schools and thus leave all or part of undergraduate education to the junior colleges and the 4-year colleges, or they can find some way to change their value system by giving more than lip service to making teaching a rewarding career.—G.DuS.



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SCIENCE

Impact of Large-Scale Science on the United States

Big science is here to stay, but we have yet to make the hard financial and educational choices it imposes.

Alvin M. Weinberg

Throughout history, societies have expressed their aspirations in large-scale, monumental enterprises which, though not necessary for the survival of the societies, have taxed them to their physical and intellectual limits. History often views these monuments as symbolizing the societies. The Pyramids, the Sphinx, and the great temple at Karnak symbolize Egypt; the magnificent cathedrals symbolize the church culture of the Middle Ages; Versailles symbolizes the France of Louis XIV; and so on. The societies were goaded into these extraordinary exertions by their rulers—the pharaoh, the church, the king-who invoked the cultural mystique when this was sufficient, but who also used force when necessary. Sometimes, as with the cathedrals, local pride and a sense of competition with other cities helped launch the project. In many cases the distortion of the economy caused by construction of the big monuments contributed to the civilization's decline.

When history looks at the 20th century, she will see science and technology as its theme; she will find in the monuments of Big Science—the huge rockets, the high-energy accelerators, the high-flux research reactors—symbols of our time just as surely as she finds in Notre Dame a symbol of the Middle Ages. She might even see analogies between our motivations for building these tools of giant science

and the motivations of the church builders and the pyramid builders. We build our monuments in the name of scientific truth, they built theirs in the name of religious truth; we use our Big Science to add to our country's prestige, they used their churches for their cities' prestige; we build to placate what ex-President Eisenhower suggested could become a dominant scientific caste, they built to please the priests of Isis and Osiris.

The emergence of Big Science and its tools as a supreme outward expression of our culture's aspirations has created many "fficult problems, both philosophic and practical. Some of the problems concern science itself, some the relation between science and our society. I shall address myself to three specific questions, all of which arise from the growth of Big Science: first, Is Big Science ruining science?; second, Is Big Science ruining us financially?; and third, Should we divert a larger part of our effort toward scientific issues which bear more directly on human well-being than do such Big-Science spectaculars as manned space travel and high-energy physics? These questions are so broad, and so difficult, that I cannot do more than raise them here. Since they involve the issue of the scientist's responsibility to his science and to his society, I believe I shall have done some service merely by urging scientists to think seriously about them.

Is Big Science Ruining Science?

The English astronomer Fred Hoyle recently set off a lively controversy by arguing against the United Kingdom's going into large-scale space research. His argument, which applies to much of Big Science, is twofold: first, that the intrinsic scientific interest of space research is not worth the money and manpower that goes into it and certainly does not justify spending more on it than on any other branch of science; and second, that wherever science is fed by too much money, it becomes fat and lazy. He claims to see evidence that the tight intellectual discipline necessary for science is, especially in America, being loosened. I shall touch later upon Hoyle's first point: Is Big Science giving us our money's worth? For the moment I want to discuss his second point, which can be paraphrased as, "Is Big Science ruining science?"

I confess that I share Hoyle's misgivings. In the first place, since Big Science needs great public support it thrives on publicity. The inevitable result is the injection of a journalistic flavor into Big Science which is fundamentally in conflict with the scientific method. If the serious writings about Big Science were carefully separated from the journalistic writings, little harm would be done. But they are not so separated. Issues of scientific or technical merit tend to get argued in the popular, not the scientific, press, or in the congressional committee room rather than in the technical-society lecture hall; the spectacular rather than the perceptive becomes the scientific standard. When these trends are added to the enormous proliferation of scientific writing, which largely remains unread in its original form and therefore must be predigested, one cannot escape the conclusion that the line between journalism and science has become blurred

The author is director of Oak Ridge National Laboratory, Oak Ridge, Tenn. This article is based on a talk given before the American Rocket Society-Oak Ridge National Laboratory Space-Nuclear Conference, Gatlinburg, Tenn., 4 May 1961.

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In the second place, one sees evidence of scientists' spending money instead of thought. This is one of the most insidious effects of large-scale support of science. In the past the two commodities, thought and money, have both been hard to come by. Now that money is relatively plentiful but thought is still scarce, there is a natural rush to spend dollars rather than thought-to order a \$10⁷ nuclear reactor instead of devising a crucial experiment with the reactors at hand, or to make additional large-scale computations instead of reducing the problem to tractable dimensions by perceptive physical approximation. The line between spending money and spending thought is blurring.

Finally, the huge growth of Big Science has greatly increased the number of scientific administrators. Where large sums of public money are being spent there must be many administrators who see to it that the money is spent wisely. Just as it is easier to spend money than to spend thought, so it is easier to tell other scientists how and what to do than to do it oneself. The big scientific community tends to acquire more and more bosses. The Indians with bellies to the bench are hard to discern for all the chiefs with bellies to the mahogany desks. Unfortunately, science dominated by administrators is science understood by administrators, and such science quickly becomes attenuated if not meaningless.

But it is fruitless to wring one's hands over the bad effects of Big Science. Big Science is an inevitable stage in the development of science and, for better or for worse, it is here to stay. What we must do is learn to live with Big Science. We must make Big Science flourish without, at the same time, allowing it to trample Little Science—that is, we must nurture small-scale excellence as carefully as we lavish gifts on large-scale spectaculars.

In respect to Big Science, huge laboratories like Oak Ridge play a central role. They were established to encourage Big Science yet to segregate it and prevent it from taking over Little Science. Big-scale science's triple diseases -journalitis, moneyitis, administratitis -have always been with us in the big laboratories. Being aware of these pitfalls we have made conscious efforts to cope with them-by requiring internal review of each publication, by occasionally sending an administrator back to his laboratory, by subjecting large expenditures to enough scrutiny so that money is not as easy to get as it may

outwardly seem to be. I do not believe that we at Oak Ridge, or I suspect at other such institutions, are completely successful in these efforts. We do the best we can, however; and at least, by confining Big Science to such institutions, we prevent the contagion from spreading.

What really bothers me is the evidence that Big Science is invading the universities. One need not look far to find Bev accelerators and megawatt research reactors on many campuses. The justification for putting these devices on university campuses is that such gadgets of Big Science are now needed to perform large parts of basic research, and that basic research is best done in conjunction with education. But I think there is a very grave danger to our universities in this incursion of Big Science. A professor of science is chosen because he is extremely well qualified as a scientist, as a thinker, or as a teacher. If he becomes too involved with Big Science he will have to become a publicist, if not a journalist, an administrator, and a spender of big money. I do not for a moment suggest that college professors are less able big-time administrators than are professional administrators. I merely point out that the proper function of a professor is to be a professor; that once Big Science has invaded his precincts and he becomes an operator (even though a very effective one), his students and his intellectual eminence and proficiency are bound to suffer. Thus, though my question "Is Big Science ruining science?" is irrelevant, since Big Science is here to stay, I do believe that Big Science can ruin our universities, by diverting the universities from their primary purpose and by converting university professors into administrators, housekeepers, and publicists.

Are there ways of bringing Big Science into the educational stream other than by converting our universities into National Laboratories? One way which is tentatively suggested in the report of the President's Science Advisory Committee, "Scientific Progress, The Universities, and The Federal Government," is to strengthen the already close relationships between the government laboratories and the universities. I would go a step further and propose the creation of technical universities close to or in conjunction with the large government laboratories. One advantage of such a scheme would be that the National Laboratories have already made their peace with Big Science-

the onerous housekeeping function, the layer of inevitable administrators and publicists, is already in being. Professors in such collaborating universities, who might be drawn in part, but not wholly, from the existing scientific staffs of the big laboratories, would not have to get involved so strongly in activities not related to their science as they would if they had to start Big Science from the beginning. In addition, the big government laboratories have facilities and technically trained personnel that are not now pulling their full weight in the educational job which must be done.

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Exactly what pattern should be established would vary from institution to institution. The Rockefeller Institute for Medical Research has recently been rechartered as the Rockefeller University -this is the most extreme possibility. I think that a more generally appropriate pattern would involve, first, a great expansion in the use of short-tenure, postdoctoral fellows at the big laboratories, and second, the establishment of independent graduate schools of technology in close proximity to the big laboratories, and with some interlocking staff. Such schools would have as much claim to federal support as do the universities which receive money for direct educational purposes as part of their payment for conducting research.

Is Big Science Ruining Us Financially?

My second question is, Is Big Science ruining us financially? The present federal expenditure on research and development is \$8.4 × 109, which is about 10 percent of the federal budget, about 1.6 percent of the gross national product. The money spent on research and development is the largest single controllable item in the federal budget in the sense that, unlike wheat subsidies or interest on the national debt, it can be changed at the President's discretion. It is not surprising, therefore, that the Bureau of the Budget has taken such an interest in our research and development budget.

The rate of change of our research and development budget, averaged over the past ten years, has been 10 percent per year; this corresponds to a doubling time of seven years. Since the doubling time of the gross national product is about 20 years, at the present rate we shall be spending all of our money on science and technology in about 65

years. Evidently something will have to be done or Big Science will ruin us financially.

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The amount that we spend on research and development is only onefifth of our military budget-and of course over 80 percent of the \$8.4 × 109 is for military purposes. There are many analogies between research expenditures and military expenditures. In neither case can one guarantee that anything useful will come of a specific expenditure; yet, on the average, we know that we must spend money for science and for defense. In both cases there is a high rate of obsolescence. Both our military and our scientific might are instruments of national policy. It therefore seems to me that the general principles which have guided our military-fiscal policy should be useful in guiding our science-fiscal policy.

We have decided, though implicitly, that our military budget shall represent about 10 percent of our gross national product. In the same way we ought soon to decide to devote a certain fraction of our gross national product to nondefense science rather than pay for each scientific expenditure on an ad hoc, item-by-item basis. At the moment science grows much more rapidly than does the gross national product. I suggest that we settle on some figure-say something less than 1 percent of the gross national product-as the long-term bill for federally supported, nondefense science, and that we stick to it for a period of, say, 15 years. Our science budget will then increase only as fast as our gross national product does, but we scientists shall have to get used to that idea.

If we settle on an over-all science budget which is geared to the gross national product, we shall have to make choices. At present each scientific expenditure is considered separately. The merits of desirable projects are argued by interested and clever proponents, but the relative merit of a project in highenergy physics as compared to a project in space or in atomic energy is not weighed in the balance. The system works because the science budget is expanding so fast. Fortunately, the President's Science Advisory Committee and the Federal Council for Science and Technology give us a mechanism for establishing an over-all science budget and for making the hard choices when we shall have to make them. These choices, which will require weighing space against biology, atomic energy against oceanography, will be the very

Table 1. Summary of shielding estimates and radiation doses. The LD₅₀ for man is about 500 rem (not rep); the military tolerance in 25 rem. [From T. Foelsche, "Protection against solar flare protons," a paper presented at the 7th annual meeting of the American Astronautical Society, Dallas, Tex., 16-18 Jan. 1961]

Shield weight	Radiation dose					
	Inner belt (D)		Flares (D)(rep)			
(g/cm ²)	rem/hr	rep/hr	Low energy (< 500 Mev)	High energy (<20 Bev)		
2	21	12	2500-25,000	80-400		
15	7.5	4.2	18-180	23-80		
25	4.5	2.5	650	23-50		

hardest of all to make—if for no other reason than that no man knows enough to make such comparative judgments on scientific grounds. The incentive for creating a favorable public opinion for a pet scientific project will become much greater than it now is; the dangers of creating a political "in" group of scientists who keep worthy outsiders from the till will be severe. Nevertheless, it is obvious that we shall have to devote much more attention than we now do to making choices between science projects in very different fields.

Can We Divert the Course of Big Science?

As an example of the kind of choice which we shall have to make, let us consider whether there are alternative scientific fields which ought to have prior claim on our resources, ahead of manned space flight or high-energy physics.

It would be naive, if not hopeless, to argue that we should not use scientific achievement as a means of competing with the U.S.S.R. Major Gagarin's feat has caught the world's fancy, and we may as well face up to it. The question is, are we wise in choosing manned flight into space as the primary event in these scientific Olympic Games? I shall argue against doing so, on three grounds—hazard, expense, and relevance.

It is my impression that the hazard of space flight, particularly the radiation hazard, is not fully assessed as yet. An admirable analysis of the radiation hazard of manned space travel is given by T. Foelsche of Langley Field. Foelsche's estimates are given in Table 1.

It is obvious from these figures that the radiation shielding for a space craft could be formidable. To shield an entire capsule against high-energy solar flares with shielding of 25 grams per square centimeter might require about 10 tons of material; to shield a man individually would require about a ton. These figures are not catastrophic. Yet I find them disturbing for several reasons. First, the measurements of the solar-flare radiation, if not of the Van Allen belt radiation, are still very uncertain. Second, the values used in all of the calculations on space shielding for relative biological effectiveness of fast heavy particles have been much lower than those used in estimates of the shielding required for the manned nuclear aircraft. This difference is usually justified by the difference in energy of the radiations in the two cases; the space radiation, being harder, has a low linear energy transfer and therefore should have low relative biological effectiveness. However, the total experimental evidence on the relative biological effectiveness of very fast particles is not very large; in any event, the secondary particles produced in spallation processes, such as occur with energetic primaries, are in the bindingenergy, not the 100-Mev, region. Finally, the biological effects of extremely energetic heavy particles are not fully understood. Although Curtis's experiments on nerve cells suggest that these particles are not too dangerous (1), the matter is not really settled.

The radiation hazard does not clearly make space an intolerable environment for man; on the other hand, it makes space a much more hostile environment than we had suspected even five years ago. That man can tramp about without shielding for extended times on the moon's surface seems to me quite unlikely. The Lord, so to speak, provided His children with a marvelous radiation shield, the atmosphere, and He did not intend them to poke their heads into His unshielded reactors. The corollary I draw is that, on the basis of what we now know, manned space travel is not definitely feasible in the sense that we can now really place a firm upper limit on the cost of a round trip to the moon; the estimates of \$20 × 10° to $$40 \times 10^9$ for this mission are so large

and cover so wide a range as to make the outsider doubt their validity on a priori grounds. May I remind you that about ten years ago the Lexington Project predicted that the cost of the nuclear-powered aircraft would be \$1 \times 10° and the time required, ten years. As it turned out, after ten years and an expenditure of \$1 \times 10°, we have words, not nuclear airplanes, flying. Just because a project is very big and very expensive does not mean that the project will be very successful.

The other main contender for the position of Number One Event in the scientific Olympics is high-energy physics. It, too, is wonderfully expensive (the Starford linear accelerator is expected to cost \$100 × 106), and we may expect to spend \$400 × 106 per year on this area of research by 1970. The issues with which such research deals have greater scientific validity than those dealt with in the manned space program, but its remoteness from human affairs is equally great. It has the advantage, from our point of view, that we are ahead of the Russians in highenergy physics.

But even if it were possible to generate around high-energy physics the same popular interest that arises naturally in connection with manned space travel, I am not persuaded that this is the battleground of choice. I personally would much rather choose scientific issues which have more bearing on the world that is part of man's everyday environment, and more bearing on

man's welfare, than have either highenergy physics or manned space travel.

There are several such areas, and we are generally very far ahead in them. The most spectacular is molecular biology-a field in which the contribution from the East is minimal. We have learned more about the essential life processes-growth, protein synthesis, and reproduction-during the past decade than during all previous history. In my opinion the probability of our synthesizing living material from nonliving before the end of the century is of the same order as the probability of our making a successful manned round trip to the planets. I suspect that most Americans would prefer to belong to the society which first gave the world a cure for cancer than to the society which put the first astronaut on Mars.

I mention also the group of economic-technical problems which arise from the increasing pressure of population on resources. Of these, nuclear energy is the best known. Here the Western lead is clear, and it is important to consolidate the lead. There are others—the problem of water, or atmospheric pollution, or of chemical contamination of the biosphere, for example. Each of these is a technical issue which can lay claim to our resources—a claim that will have to be heard when we make choices.

But it is presumptuous for me to urge that we study biology on earth rather than biology in space, or physics in the nuclear binding-energy region, with its clear practical applications and its strong bearing on the rest of science, rather than physics in the Bev region, with its absence of practical applications and its very slight bearing on the rest of science. What I am urging is that these choices have become matters of high national policy. We cannot allow our over-all science strategy, when it involves such large sums, to be settled by default, or to be pre-empted by the group with the most skillful publicity department. We should have extensive debate on these over-all questions of scientific choice; we should make a choice, explain it, and then have the courage to stick to a course arrived at

In making our choices we should remember the experiences of other civilizations. Those cultures which have devoted too much of their talent to monuments which had nothing to do with the real issues of human well-being have usually fallen upon bad days: history tells us that the French Revolution was the bitter fruit of Versailles. and that the Roman Colosseum helped not at all in staving off the barbarians. So it is for us to learn well these lessons of history: we must not allow ourselves, by short-sighted seeking after fragile monuments of Big Science, to be diverted from our real purpose, which is the enriching and broadening of human

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1. H. J. Curtis, Science 133, 312 (1961),

CURRENT PROBLEMS IN RESEARCH

Ice Alloys

For arctic operations ice and snow can be improved as structural materials by appropriate alloying.

W. D. Kingery

Ice and snow have been used as construction materials by indigenous arctic peoples for a long time. Applications of ice include roads, bridges, and staging areas for logging operations; snow has been used for houses. In

each of these uses the properties required of the material are not stringent, and the builders have used, by and large, the natural, unimproved materials.

More recently, extensive progress

has been made by the U.S. Army in developing methods of excavating tunnels and constructing chambers in glacial ice and snow. Similarly, compacted snow areas were used as roads and parking areas for thousands of automobiles during the 1960 Winter Olympics at Squaw Valley, California, and compacted snow roads and ice runways for aircraft have been used during IGY activities in Antarctica (1). In such construction, the physical properties of the material used determines to a large extent the operational capabilities of the product. Present limitations on the use of ice and snow as structural materials are of two kinds: (i) the engineering properties of ice and snow in the natural state are rather poor; (ii) improved processing techniques are needed for forming the raw materials into useful shapes. The present discussion is limited to consideration of

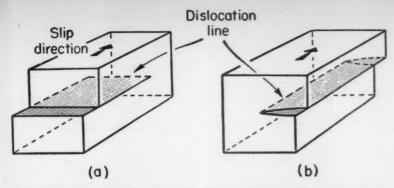


Fig. 1. Dislocation in crystal structure is a line imperfection which separates the part of the crystal that has slipped by plastic deformation from the portion that has not slipped. The line can be (i) normal to the direction of deformation (a); (ii) an edge dislocation; (iii) parallel to the direction of deformation (b); (iv) a screw dislocation; or (v) a combination of these.

properties of the material, and, in particular, of ways to improve the natural materials.

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Since arctic areas, along with the oceans, remain the earth's great unexploited frontier, development of new construction materials and new understanding of the behavior of naturally abundant materials under natural and artificial conditions are also of great importance. In the past, and perhaps at present, most arctic and glaciological research has consisted of observation, exploration, and mapping, but scientists are now taking a more quantitative approach in explaining and systematizing observations of natural phenomena. In recent years, efforts have been made to develop ice alloys in much the same way that metallurgical alloys, superior to metals found in nature, were developed (2).

To date, the most extensive effort to utilize ice and snow as a structural material was the British attempt to design and construct aircraft carriers of ice during World War II (3). This effort was conceived as a possible solution to the desperate problem of extending the air cover beyond that provided by airplanes based on the British Isles in 1942. Various suggestions for using natural materials, such as icebergs or arctic ice floes, proved to be impractical, and a serious effort was made to find an ice structure which would be more useful. This resulted in the development of an icesawdust mixture, which was named "pykrete." This product was stronger than natural ice and of more uniform properties, and it provided the basis for a program of aircraft-carrier design. The exigencies of the war situation changed, however, and this project was never carried to completion.

In planning the development of other ice alloys it was essential to consider the sources of strength in various materials. Such investigations have been most thoroughly documented in regard to metals. One objective of the work under discussion has been to determine just how many of these findings are paralleled in a new base material such as ice.

Origin of Strength at Low Temperatures

The basis for understanding the strength behavior of most metallurgical alloys at low temperatures is the successful application, in recent years, of dislocation theory (4-6). In metals, dislocations or line imperfections (the line is the boundary which separates a region over which deformation has taken place from the region where deformation has not yet occurred) lead to plastic deformation, as shown in Fig. 1. Strengthening is accomplished by eliminating dislocations or by preventing a dislocation from moving along in its slip plane. Such motion can be prevented or reduced by introducing impurities into the structure, which tend to concentrate at dislocation sites and prevent motion; or by adding a second component that gives an ordered structure, so that the work required to move a dislocation is increased; or by prior deformation

(cold work), which introduces enough new dislocations in the structure to make it difficult for those already present to move. A second general method of increasing strength consists of the addition, as a second phase, of hard particles which tend to key the slip plane on which deformation occurs and thereby increase the stress necessary for deformation.

In contrast to the yield strength that characterizes the plastic deformation of metals, in ceramics brittle fracture occurs with negligible plastic deformation. The causes of fracture in different materials have not been critically defined, but various processes can lead to the formation of small cracks. At the tip of each crack, stress concentration leads to high local stresses and ultimate fracture. The Griffith criterion for fracture is that the strain energy released by crack propagation is equal to the surface energy of the new surfaces formed. This criterion is met even when slight plastic deformation occurs at the tip of the crack; in that case allowance is made for the energy-absorbing process by use of the phrase "apparent surface energy" (6, 7). The causes of microcracks or Griffith flaws, which act as stress concentrators, are varied. With the exception of prior deformation, the most common cause is surface abrasion, particularly for glass and ceramics. It is well known, for example, that the fracture strength of glass is above 1 million pounds per square inch if the surface is carefully protected; strength of about 10,000 pounds per square inch is usual.

Origin of Strength at High Temperatures

At high temperatures, a new element is introduced into the strength behavior of all materials. This results from increased atomic mobility; dislocations in the crystal are no longer restricted to one crystallographic plane but can shift to an adjacent plane by a process called dislocation "climb." This greater freedom makes it easier for dislocations to be freed from concentrations of impurities or from blocking particles in their path. As a result, extensive deformation can occur prior to fracture; creep, or a pseudoviscous behavior, is observed. On annealing at high temperatures, any dislocations present tend to line up in positions of low energy, as shown in Fig. 2.

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The increased atomic mobility at high temperatures greatly reduces the effectiveness of solid solution, ordered structures, and prior deformation as strengthening techniques. The method which remains most suitable is that of adding hard particles as a second phase which restricts dislocation motion. This restriction does not completely eliminate dislocation mobility and deformation, since dislocations can climb out of their normal slip planes and so circumvent a restricting particle. In metallurgical processing a second

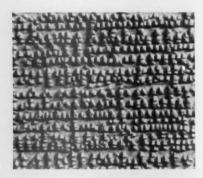






Fig. 2. (Top) The ends of dislocations are marked by etch pits in a crystal of Al_2O_3 which has been deformed. (Middle) At high temperatures these dislocations are mobile and line up in polygon boundaries. (Bottom) Polygons separated by these boundaries are visible in polarized light. These same phenomena are also observed in deformed ice. [Peter Gibbs, department of physics, University of Utah; after W. D. Kingery, Introduction to Ceramics (Wiley, New York, 1960)]

serious problem exists; adding hardening particles of fine particle size is best accomplished through precipitation reactions, but the particles tend to go into solution at high temperatures. This has led to new techniques in the development of metallurgical alloys—techniques in which dispersion-hardened alloys prepared by mixing in the hard particles are used, rather than heat-treated, precipitation-hardened materials.

A high-temperature strengthening method which has been discussed for metallurgical alloys but is employed mainly for soft materials such as plastics is the addition of fibers rather than particles as reinforcement. In order for such reinforcements to be effective in preventing fracture, the fiber must (i) be much stronger than the matrix material and (ii) have a much higher modulus of elasticity, so that most of the applied stress is carried by the reinforcing material rather than by the soft, deformable matrix. This kind of reinforcement is effective only over a temperature range within which there is a wide difference between both the strength and the deformation characteristics of matrix and fiber. This is the case when the reinforcing additive at low relative temperature (low with respect to its own properties) is dispersed in a matrix material which is at a high relative temperature.

Development of Ice Alloys

Principles. For success in the development of ice alloys, it is necessary to have good information on the properties of ice and on its behavior with regard to deformation and fracture. Fortunately, many such investigations have been made, and the deformation and fracture behavior have been carefully observed. In general, ice is similar to other materials in these respects; it is particularly closely related to sapphire (Al₂O₃), to which it is similar in crystallographic structure. Aluminum oxide, like glass, fails with brittle fracture at low temperatures, but at high temperatures in an oxyacetylene flame, deformation occurs, and a rod of material can easily be bent (Fig. 3). If the rod is suddenly pulled apart instead of being slowly deformed, brittle fracture results, even near the melting point. In aluminum oxide, these characteristics have been related to the crystal structure and the kinds of dis-

Table 1. Strength of fresh ice with sawdust and Fiberglas, respectively, added.

	Modulus of rupture (kg/cm²)			
Addition (%)	Sawdust (-17°C)	Fiberglas (-20°C)		
0	22.5	24.1		
0.8	22.7	24.0		
2.5	35	65.4		
9.0	60	161		
14.0	66.7			

locations which it is possible to introduce (8). Slip deformation in aluminum oxide always takes place along the basal plane of the hexagonal structure.

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Ice has hexagonal symmetry-a fact well known to anyone who has seen a snowflake-and the structure can be considered to consist of stacked layers. At high temperatures, when slowly deformed, these layers tend to slip over one another like a pack of cards, and deformation readily occurs. At high rates of deformation, however, brittle fracture occurs; the moving dislocations are apparently unable to achieve a sufficiently high velocity or rate of multiplication to keep up with a quickly applied load. As the temperature is lowered, the rate of deformation is sharply reduced, and brittle fracture occurs even when loads are applied more slowly. However, deformation occurs when the load is static or applied slowly, even at temperatures of -40°C, and fracture does not occur immediately. Observations of different strengths and deformation characteristics for different loading rates (the viscoelastic characteristics of ice) have led to some confusion in the literature. Nevertheless, it is clear that ice behaves like a material deformable at high temperature and tends to flow under an applied stress when used for structural purposes where loads must be carried for significant periods. As a result, the kinds of alloys which may be developed are those characteristic of high-temperature systems.

One result of these findings on the effect of temperature is the demonstration that alloying additives in solution (few materials are soluble in ice anyway) cannot be expected to produce useful alloys under the "high-temperature" conditions essential for the development of proper alloys. As found from long experience with metals, plastics, and ceramics, the kinds of alloys which are most useful under these conditions are those made with stable second-phase additives having

useful properties. Three different kinds of additives have been tried: (i) dispersed particulate material of high elastic modulus and high strength; (ii) fibrous material having good ductility and moderate strength; and (iii) fibrous material having high elastic modulus and high strength. Combination of these materials and sophisticated development of particular compositions have not been attempted.

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Dispersed particulate material. Investigations of the use of hard particles as additives were carried out by adding kaolinite of fine particle size as a dispersion material during the solidification process. Studies were made of short-time strength and of deformation characteristics. It was found that the short-time strength was not improved by the addition of kaolinite. However, the rate of deformation under a fixed stress was substantially reduced by these additions, as illustrated in Fig. 4. This finding is in general agreement with expectations from extensive metallurgical studies of dispersion hardening.

Deformable fibrous material. A deformable material, wood fiber, was tested extensively as a second-phase constituent in connection with the development of pykrete. Results of this study have been discussed by Perutz (3). They show that the addition of wood pulp to ice substantially increases short-time strength, increases resistance to deformation, and also increases resistance to impact and shock loading. With the addition of sawdust (about 15 percent by volume) the strength was increased by a factor of about 3, as shown in Table 1. Even more important, the reproducibility of strength values was much improved, so that the safety factor required for design purposes was much reduced.

Fiber of high strength and elasticity. For the temperature range from 0° to -40°C, an outstanding candidate as an alloying additive for ice is fibrous glass such as is used in reinforced plastics. Glass fibers have a high modulus of elasticity as compared to ice (10 million lb/in.2 as compared to about 0.2 million lb/in.3 for ice) and also high strength (about 250,000 lb/in.3 as compared to 150 lb/in.2 for ice). As a result of the high modulus of elasticity, an applied load is carried in large measure by the glass fibers, and the stress induced in the ice is limited to a minimum value. Experimental results more than exceeded expectations. The addition of Fiberglas (about 5 percent by volume) gave more than a



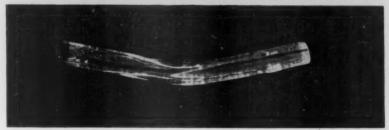


Fig. 3. Deformation (top) of a single crystal of sapphire at high temperature (in an oxyacetylene flame) and (bottom) of ice at a high relative temperature (close to the melting point).

tenfold increase in strength, as shown in Table 1. In addition, there was great improvement in deformation characteristics, as shown in Fig. 4.

Implications for Materials Science

The President's Science Advisory Committee, many other advisory committees to the Department of Defense, the National Academy of Sciences, and others have emphasized that we are up against a materials barrier in many areas of science and technology. New technical developments are often blocked by an inability to obtain materials with particular mechanical, electrical, optical, or thermal characteristic in a controlled and reproducible way. It is interesting to consider the implications for materials science of current studies of ice alloys.

The development of ice alloys has been based largely on the scientific understanding of fracture and deformation phenomena obtained by metallurgists and ceramists. Our current under-

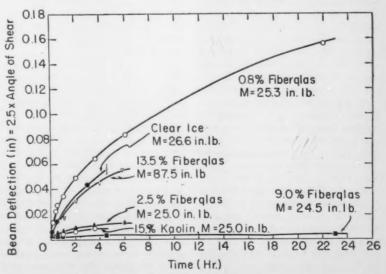


Fig. 4. Deformation of ice with various additions of kaolinite particles or glass fibers with bending moment M. The slope of the curve is the measure of apparent viscosity. [From W. D. Kingery (2)]

standing of fracture phenomena, recently reviewed (6), goes back to investigations by Griffith in 1920-21 (7). Our understanding of deformation characteristics is based on our knowledge of imperfections in crystals, called dislocations. Phenomena relating to dislocations have been intensively studied in recent years, but the essential idea was introduced by Orowan, Taylor, and others in the 1930's. On the basis of data on the mechanical behavior of pure ice and our current level of understanding of the mechanical properties of materials, it has been possible to predict the general behavior of potential ice-alloy systems and to concentrate research activity in areas suggested by our understanding of phenomena rather than by intuitive inventiveness.

Application of materials science and technology to a new system such as ice emphasizes the disparity between concepts limited by discipline (glaciology, metallurgy, ceramics, and so on) and those in which there are no artificial, disciplinary barriers. This is a case where exchange of information between different scientific disciplines has proved to be useful and effective

References and Notes

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- 1. E. Moser (Naval Civil Engineering Labora-
- tory), private communication.

 2. W. D. Kingery, J. Glaciol. 3, 577 (1960).

 3. M. F. Perutz, ibid. 1, 95 (1948).

 4. A. H. Cottrell, Dislocations and Plastic Flow
- Crystals (Clarendon, Oxford, England, 1953).
- 1953). W. T. Read, Jr., Dislocations in Crystals (McGraw-Hill, New York, 1953). B. L. Averbach, D. K. Felbeck, G. T. Hahn, D. A. Thomas, Eds., Fracture (Technology (Technology
- D. A. Thomas, Eds., Fracture (Technology Press of Massachusetts, Cambridge; Wiley, New York; 1960).
 7. A. A. Griffith, Phil. Trans. Roy. Soc. London A221, 163 (1920-21).
 8. M. L. Kronberg, Acta Met. 5, 507 (1957).
 9. This study was carried out as part of a program at the Massachusetts Institute of Technology spaced by the Terrestrial. Technology sponsored by the Terrestrial Sciences Laboratory, Geophysics Research Laboratory, under contract No. AF 19(604)-

Is There a Sensory Threshold?

When the effects of the observer's response criterion are isolated, a sensory limitation is not evident.

John A. Swets

One hundred years ago, at the inception of an experimental psychology of the senses, G. T. Fechner focused attention on the concept of a sensory threshold, a limit on sensitivity. His Elemente der Psychophysik described three methods-the methods of adjustment, of limits, and of constants-for estimating the threshold value of a stimulus (1). The concept and the methods have been in active service since. Students of sensory processes have continued to measure the energy required for a stimulus to be just detectable, or the difference between two stimuli necessary for the two to be just noticeably different. Very recently there has arisen reasonable doubt that sensory thresholds exist.

The threshold thought to be characteristic of sensory systems has been regarded in the root sense of that word as a barrier that must be overcome. It is analogous to the threshold discovered by physiologists in single neurons. Just as a nervous impulse either occurs or does not occur, so it has been thought that when a weak stimulus is presented

we either detect it or we do not, with no shades in between. The analogy with the neuron's all-or-none action, of course, was never meant to be complete; it was plain that at some point above the threshold sensations come in various sizes.

From the start the triggering mechanism of the sensory systems was regarded as inherently unstable. The first experiments disclosed that a given stimulus did not produce a consistent "yes" ("I detect it") response or a consistent "no" ("I do not detect it") response. Plots of the "psychometric function" -the proportion of "yes" responses as a function of the stimulus energy-were in the form of ogives, which suggested an underlying bell-shaped distribution of threshold levels. Abundant evidence for continuous physiological change in large numbers of receptive and nervous, elements in the various sensory systems made this picture eminently reasonable. Thus, the threshold value of a stimulus had to be specified in statistical terms. Fechner's experimental methods were

designed to obtain good estimates of the mean and the variance of the threshold distribution.

It was also assumed from the beginning that the observer's attitude affects the threshold estimate. The use of ascending and descending series of stimulus energies in the method of limits, to take one example, is intended to counterbalance the errors of "habituation" and "anticipation"—errors to which the observer is subject for extrasensory reasons. Typically, investigators have not been satisfied with experimental observers who were merely well motivated; they have felt the need for elite observers. They have attempted, by selection or training, to obtain observers who could maintain a reasonably constant criterion for a "yes" response.

The classical methods for measuring the threshold, however, do not provide a measure of the observer's response criterion that is independent of the threshold measure. As an example, we may note that a difference between two threshold estimates obtained with the method of limits can be attributed to a criterion change only if it is assumed that sensitivity has remained constant, or to a sensitivity change only if it is assumed that the criterion has remained constant. So, although the observer's response criterion affects the estimate of the threshold, the classical procedures do not permit calibration of the observer with respect to his response criterion.

Within the past ten years methods

The author is associate professor of psychology and a staff member of the Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge. This article is adapted from an address delivered at a centennial symposium honoring Fechner, sponsored by the American Psychological Association and the Psychometric Society, held in Chicago in September 1960.

have become available that provide a reliable, quantitative specification of the response criterion. These methods permit isolation of the effects of the criterion, so that a relatively pure measure of sensitivity remains. Interestingly, the data collected with these methods give us good reason to question the existence of sensory thresholds, to wonder whether anything more than a response criterion is involved in the dichotomy of "yes" and "no" responses. There is now reason to believe that sensory excitation varies continuously and that an apparent threshold cut in the continuum results simply from restricting the observer to two categories of response.

The methods that permit separating the criterion and sensitivity measures, and a psychophysical theory that incorporates the results obtained with these methods, stem directly from the modern approach taken by engineers to the general problem of signal detection. The psychophysical "detection theory," like the more general theory, has two parts. One part is a literal translation of the theory of testing statistical hypotheses, or statistical decision theory. It is this part of the theory that provides a solution to the criterion estimation problem and deals with sensitivity as a continuous variable. The second part is a theory of ideal observers. It specifies the mathematically ideal detection performance-the upper limit on detection performance that is imposed by the environment-in terms of measurable parameters of the signal and of the masking noise (2).

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We shall turn in a moment to a description of the theory and to samples of the supporting data. Before proceeding any further, however, we must note that, although Fechner started the study of sensory functions along lines we are now questioning, he also anticipated the present line of attack in both of its major aspects. For one thing, he regarded Bernoulli's ideas on statistical decision as highly relevant to psychophysical theory (3). More important, while advancing the concept of a threshold, he spoke also of what he called "negative sensations"—that is, of a grading of sensory excitation below the threshold. That subsequent workers in the field of psychophysics have shown little interest in negative sensations is apparent from the fact that, 75 years after Fechner's work, Boring could write: "So also a sensation either occurs from stimulation or it does not. If it does not, it has no demonstrable intensity. Fechner talked about negative

(subliminal) degrees of intensity, but that is not good psychology today. Above the limen we can sense degrees of intensity, but introspection cannot directly measure these degrees. We are forced to comparison, and there again we meet an all-or-none principle. Either we can observe a difference or we cannot. Introspection as to the amount of difference is not quantitatively reliable" (4).

Decision Aspects of Signal Detection

How detection theory succeeds in estimating the response criterion may be described in terms of "the fundamental detection problem." The experimenter defines an interval of time for the observer, and the observer must decide whether or not a signal is present during the interval. It is assumed that every interval contains some random interference, or noise-noise that is inherent in the environment, or is produced inadvertently by the experimenter's equipment for generating signals, or is deliberately introduced by the experimenter, or is simply a property of the sensory system. Some intervals contain a specified signal in addition to the background of noise. The observer's report is limited to these two classes of stimulus events-he says either "yes" (a signal was present) or "no" (only noise was present). Note that he does not say whether or not he saw (or heard) the signal; he says whether, under the particular circumstances, he prefers the decision that it was present or the decision that it was absent.

There is presumably, coinciding with the observation interval, some neural activity in the relevant sensory system. This activity forms the sensory basis—a part of the total basis—for the observer's report. This "sensory excitation," as we shall call it, may be in fact either simple or complex; it may have many dimensions or few; it may be qualitative or quantitative; it may be anything. The exact, or even the general, nature of the actual sensory excitation is of no concern to the application of the theory.

Only two assumptions are made about the sensory excitation. One is that it is continually varying; because of the ever-present noise, it varies over time in the absence of any signal, as well as from one presentation to the next of what is nominally the same signal. The other is that the sensory

excitation, insofar as it affects the observer's report, may be represented as a unidimensional variable. In theory, the observer is aware of the probability that each possible excitatory state will occur during an observation interval containing noise alone and also during an observation interval containing a signal in addition to the noise, and he bases his report on the ratio of these two quantities, the likelihood ratio. The likelihood ratio derived from any observation interval is a real, nonzero number and hence may be represented along a single dimension.

The likelihood-ratio criterion. The observer's report after an observation interval is supposed to depend upon whether or not the likelihood ratio measured in that interval exceeds some critical value of the likelihood ratio, a response criterion. The criterion is presumed to be established by the observer in accordance with his detection goal and the relevant situational parameters. If he wishes to maximize the number of correct responses, his criterion will depend upon the a priori probability that a signal will occur in a given interval. If he chooses to maximize the total payoff, his criterion will depend on this probability and also on the values and costs associated with the four possible outcomes of a decision. Several other detection goals can be defined; the way in which each of them determines the criterion has been described elsewhere (5). In any case, the criterion employed by the observer can be expressed as a value of the likelihood ratio. Thus, the observer's decision about an interval is based not only on the sensory information he obtains in that interval but also upon advance information of various kinds and upon his motivation.

Next, consider a probability defined on the variable likelihood ratio-in particular, the probability that each value of likelihood ratio will occur with each of the classes of possible stimulus events: noise alone and signal plus noise. There are, then, two probability distributions. The one associated with signal plus noise will have a greater mean (indeed, its mean is assumed to increase monotonically with increases in the signal strength, but for the moment we are considering a particular signal). Now, if the observer follows the procedure we have described—that is, if he reports that the signal is present whenever the likelihood ratio exceeds a certain criterion and that noise alone is present whenever the likelihood

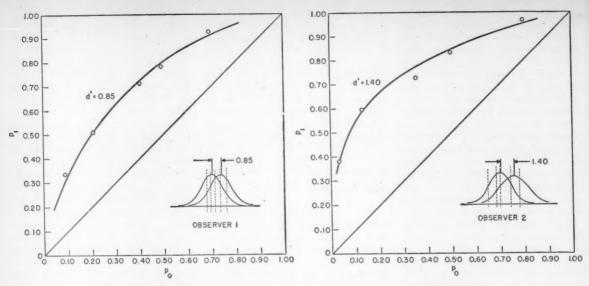


Fig. 1. Two theoretical operating-characteristic curves, with data from a yes-no experiment.

ratio is less than this criterion—then, from the fourfold stimulus-response matrix that results, one can extract two independent measures: a measure of the observer's response criterion and a measure of his sensitivity.

The operating characteristic. The extraction of these two measures depends upon an analysis in terms of the operating characteristic. If we induce the observer to change his criterion from one set of trials to another, and if, for each criterion, we plot the proportion of "yes" reports made when the signal is present (the proportion of hits, or p1) against the proportion of "yes" reports made when noise alone is present (the proportion of false alarms, or p_0), then, as the criterion varies, a single curve is traced (running from 0 to 1.0 on both coordinates) that shows the proportion of hits to be a nondecreasing function of the proportion of false alarms. This operating-characteristic curve describes completely the successive stimulus-response matrices that are obtained, since the complements of these two proportions are the proportions that belong in the other two cells of the matrix. The particular curve generated in this way depends upon the signal and noise parameters and upon the observer's sensitivity; the point on this curve that corresponds to any given stimulus-response matrix represents the criterion employed by the observer in producing that matrix.

It has been found that, to a good approximation, the operating-characteristic

curves produced by human observers correspond to theoretical curves based on normal probability distributions. These curves can be characterized by a single parameter: the difference between the means of the signal-plusnoise and noise-alone distributions divided by the standard deviation of the noise distribution. This parameter has been called d'. Moreover, the slope of

the curve at any point is equal to the value of the likelihood-ratio criterion that produces that point.

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The yes-no experiment. The procedure employed in the fundamental detection problem is often referred to as the "yes-no procedure," and we shall adopt this terminology. Two operating-characteristic curves resulting from this procedure are shown in Fig. 1. The

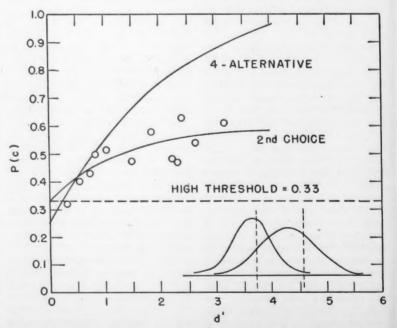


Fig. 2. The results obtained in a second-choice experiment, shown with the prediction from detection theory. [Data from J. A. Swets, W. P. Tanner, Jr., T. G. Birdsall (5)]

data points were obtained in an auditory experiment in which the observers attempted to detect a tone burst in a background of white noise. The curves are the theoretical curves that fit the data best. The inserts at lower right in the two graphs show the normal probability distributions underlying the curves, and the five criteria corresponding to the data points. In this particular experiment the observers changed their criteria from one set of trials to another as the experimenter changed the a priori probability of the occurrence of the signal. The distance between the means of the two distributions is shown as 0.85 for observer No. 1 and as 1.40 for observer No. 2; this distance is equal to d' under the convention that the standard deviation of the noise distribution is unity.

We may note that the curve fitted to the data of the first observer is symmetrical about the negative diagonal, and that the curve fitted to the data of the second observer is not. Both types of curves are seen frequently; the second curve is especially characteristic of data collected in visual experiments. Theoretically, the curve shown in the graph at left will result if the observer knows the signal exactly-that is, if he knows its frequency, amplitude, starting time, duration, and phase. A theoretical curve like the one shown in the graph at right results if the observer has inadequate information about frequency and phase, or, as is the case when the signal is a white light, if there is no frequency and phase information. The probability distributions that are shown in the inserts reflect this difference between the operating-characteristic curves.

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Both of the curves shown are based on the assumption that sensory excitation is continuous, that the observer can order values of sensory excitation throughout its range. Two other experiments have been employed to test the validity of this assumption: one involves a variant of the forced-choice procedure; the other involves a rating procedure. We shall consider these experiments in turn.

The second-choice experiment. In the forced-choice procedure, four temporal intervals were defined on each trial, exactly one of which contained the signal. The signal was a small spot of light projected briefly on a large, uniformly illuminated background. Ordinarily, the observer simply chooses the interval he believes most likely to

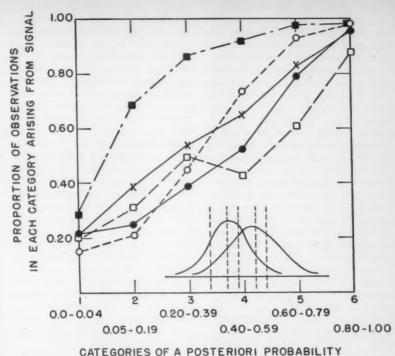


Fig. 3. The results of a rating experiment. [Data from J. A. Swets, W. P. Tanner, Jr., T. G. Birdsall (5)]

have contained the signal. In this experiment the observer made a second choice as well as a first.

The results are shown in Fig. 2. The top curve is the theoretical function relating the proportion of correct first choices to d'; the lower curve is the theoretical relation of the proportion of correct second choices to d'. The points on the graph represent the proportions of correct second choices obtained by experiment. They are plotted at the value of d' corresponding to the observed proportion of correct first choices.

It may be seen that the data points are fitted well by the theoretical curve. The rather considerable variability can be attributed to the fact that each point is based on less than 100 observations. In spite of the variability, it is clear that the points deviate significantly from the horizontal dashed line. The dashed line may be taken as a baseline; it assumes a sensory threshold such that it is exceeded on only a negligible proportion of the trials when noise alone is presented. Should such a threshold exist, the second choice would be correct only by chance. The data indicate that the observer is capable of ordering values of sensory excitation well below this point. Two sensory thresholds are shown in the insert at lower right in Fig. 2. The threshold on the right, at three standard deviations from the mean of the noise distribution, corresponds to the horizontal dashed line in the upper part of the figure. The data indicate that, were a threshold to exist, it would have to be at least as low as the left-hand threshold, at approximately the mean of the noise distribution.

The rating experiment. In the rating procedure, as in the yes-no procedure, a signal is either presented or not presented in a single observation interval. The observer's task is to reflect gradations in the sensory excitation by assigning each observation to one of several categories of likelihood of occurrence of a signal in the interval.

The results of a visual experiment are displayed in Fig. 3. The abscissa represents a six-point scale of certainty concerning the occurrence of a signal. The six categories were also defined in terms of the a posteriori probability of occurrence, but, for our purpose, only the property of order need be assumed. The ordinate shows the proportion, of the observations placed in each category, that resulted from the presentation of the signal.

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Five curves are shown in Fig. 3. Four of them correspond to the four observers; the fifth, marked by ×'s, represents the average. It may be seen that the curves for three of the four observers increase monotonically, while that for the fourth has a single reversal. The implication is that the human observer can distinguish at least six categories of sensory excitation.

It is possible to compute operatingcharacteristic curves from these data, by regarding the category boundaries successively as criteria. The curves (not shown here) are very similar in appearance to those obtained with the yes-no procedure (5). By way of illustration, the five criteria used by one of the observers (the one represented by solid circles) are shown in the insert at lower right in Fig. 3.

The experimental invariance of d'. It has been found experimentally, in vision (5) and in audition (6), that the sensitivity measure d' remains relatively constant with changes in the response criterion. Thus, detection theory provides a measure of sensitivity that is practically uncontaminated by the factors that might be expected to affect the observer's attitude.

It has also been found that the measure d' remains relatively invariant with different experimental procedures. For vision (7) and audition (8) the estimates of d' from the yes-no procedure and from the four-interval, forced-choice procedure are very nearly the same. Again, consistent estimates are obtained from forced-choice procedures with 2, 3, 4, 6, and 8 intervals (8). Finally, the rating procedure yields estimates of d' indistinguishable from those obtained with the yes-no procedure (9).

Thus, the psychophysical detection theory has passed some rather severe tests—the quantity that is supposed to remain invariant does remain invariant. This finding may be contrasted with the well-known fact that estimates of the threshold depend heavily on the particular procedure used.

Theory of Ideal Observers

Detection theory states, for several types of signal and noise, the maximum possible detectability as a function of the parameters of the signal and the noise. Given certain assumptions, this relationship can be stated very precisely. The case of the "signal specified

exactly" (in which everything about the signal is known, including its frequency, phase, starting time, duration, and amplitude) appears to be a useful standard in audition experiments. In this case, the maximum d' is equal to the quantity $(2E/N_0)^{\frac{1}{2}}$, in which E is the signal energy and N_0 is the noise power in a one-cycle band. An ideal observer for visual signals has also been defined (10).

It can be argued that a theory of ideal performance is a good starting point in working toward a descriptive theory. Ideal theories involve few variables, and these are simply described. Experiments can be used to uncover whatever additional variables may be needed to describe the performance of real observers. Alternatively, experiments can be used to indicate how the ideal theory may be degraded—that is, to identify those functions of which the ideal detection device must be deprived—in order to accurately describe real behavior.

Given a normative theory, it is possible to describe the real observer's efficiency. In the present instance, the efficiency measure η has been defined as the ratio of the observed to the ideal (d')2. It seems likely that substantive problems will be illuminated by the computation of η for different types of signals and for different parameters of a given type of signal. The observed variation of this measure should be helpful in determining the range over which the human observer can adjust the parameters of his sensory system to match different signal parameters (he is, after all, quite proficient in detecting a surprisingly large number of different signals), and in determining which parameters of a signal the observer is not using, or not using precisely, in his detection process (11).

The human observer, of course, performs less well than does the ideal observer in the great majority of detection tasks, if not in all. The interesting question concerns not the amount but the nature of the discrepancy that is observed

The human observer performs less well than the ideal observer defined for the case of the "signal specified exactly." That is to say, the human observer's psychometric function is shifted to the right. More important, the slope of the human observer's function is greater than that of the ideal function for this particular case—a result sometimes referred to as "low-signal suppression."

Let us consider three possible reasons for these discrepancies.

First, the human observer may well have a noisy decision process, whereas the ideal decision process is noiseless. For example, the human observer's response criterion may be unstable. If he vacillates between two criteria, the resulting point on his operating-characteristic curve will be on a straight line connecting the points corresponding to the two criteria; this average point falls below the curve (a curve with smoothly decreasing slope) on which the two criteria are located. Again, the observer's decision axis may not be continuous. It may be, as far as we know, divided into a relatively small number of categories-say, into seven.

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A second likely cause of deviation from the ideal is the noise inherent in the human sensory systems. Consistent results are obtained from estimating the amount of "internal noise" (that is, noise in the decision process and noise in the sensory system) in two ways: by examining the decisions of an observer over several presentations of the same signal and noise (on tape) and by examining the correlation among the responses of several observers to a single presentation (12).

A third, and favored, possibility is faulty memory. This explanation is favored because it accounts not only for the shift of the human observer's psychometric function but also for the greater slope of his function. The reasoning proceeds as follows: If the detection process involves some sort of tuning of the receptive apparatus, and if the observer's memory of the characteristics of the incoming signal is faulty, then the observer is essentially confronted with a signal not specified exactly but specified only statistically. He has some uncertainty about the incoming signal.

If uncertainty is introduced into the calculations of the psychometric function of the ideal detector, it is found that performance falls off as uncertainty increases, and that this decline in performance is greater for weak signals than for strong ones (13). That is, a family of theoretical uncertainty curves shows progressively steeper slopes coinciding with progressive shifts to the right. This is what one would expect; the accuracy of knowledge about signal characteristics is less critical for strong signals, since strong signals carry with them more information about these characteristics.

It has been observed that visual data (10) and auditory data (14) are fitted well, with respect to slope, by the theoretical curve that corresponds to uncertainty among approximately 100 orthogonal signal alternatives. It is not difficult to imagine that the product of the uncertainties about the time, location, and frequency of the signals used in these experiments could be as high as 100.

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It is possible to obtain empirical corroboration of this theoretical analysis of uncertainty in terms of faulty memory. This is achieved by providing various aids to memory within the experimental procedure. In such experiments, memory for frequency is made unnecessary by introducing a continuous tone or light (a "carrier") of the same frequency as the signal, so that the signal to be detected is an increment in the carrier. This procedure also eliminates the need for phase memory in audition and location memory in vision. In further experiments a pulsed carrier is used in order to make unnecessary memory for starting time and for duration. In all of these experiments a forced-choice procedure is used, so that memory for amplitude beyond a single trial can also be considered irrelevant. In this way, all of the information thought to be relevant may be contained in the immediate situation. Experimentally, we find that the human observer's psychometric functions show progressively flatter slopes as more and more memory aids are introduced. In fact, when all of the aids mentioned above are used, the observer's slope parallels that for the ideal observer without uncertainty, and it deviates as little as 3 decibels from the ideal curve in absolute value (14).

Relationship of the Data to Various Threshold Theories

Although there is a limit on detection performance, even ideally, and although the human observer falls short of the limit, these facts do not imply a sensory threshold. We have just seen that the human observer's performance can be analyzed in terms of memory, and, conceivably, additional memory aids could bring his performance closer to the ideal. Moreover, consideration of ideal observers concerns an upper rather than a lower limit. The human observer, while falling short of the ideal, can still detect signals at a high rate. Ideally,

any displacement of the signal-plusnoise distribution from the noise-alone distribution will lead to a detection rate greater than chance. Although it is difficult to obtain data near the chance point, the theoretical curves that fit the plots of d' against signal energy for human observers go through zero on the energy scale.

This last-mentioned result, of course, based as it is on extrapolation, cannot stand by itself as conclusive argument against the existence of a threshold. The result also depends on a measure of performance that is specific to detection theory. So we shall not be concerned with it further. It is possible, however, to relate the various threshold theories that have been proposed to the experimental results discussed earlierresults obtained with the ves-no, second-choice, and rating procedures, as shown in Figs. 1, 2, and 3. We shall examine these results in relation to threshold theories proposed by Blackwell (15), Luce (16), Green (17). Swets, Tanner, and Birdsall (5), and Stevens (18).

Blackwell's high-threshold theory. Blackwell's theory assumes that, whereas the observer may be led to say "yes" when noise alone is presented, only very infrequently is his threshold exceeded by the sensory excitation arising from noise-so infrequently, in fact, that these instances can be ignored. There is a "true" value of po-call it po' -that for all practical purposes is equal to zero. Corresponding to po', there is some true p1', the value of which depends on the signal strength. Since the observer is unable to order values of sensory excitation below $p' \approx 0$, if he says "yes" in response to such a value he is merely guessing and will be correct on a chance basis. The operatingcharacteristic curve (for a given signal strength) that results from this theory is that of Fig. 4. It is a straight line from (p_0', p_1') through $(p_0 = 1.00,$ $p_1 = 1.00$). The insert at lower right shows the location of the threshold. The data of observer 1 shown in Fig. 1 are reproduced for comparison.

This theoretical curve is described by the equation

$$p_1 = p_1' + p_0(1 - p_1') \tag{1}$$

The observed proportion of "yes" responses to a signal (p_1) equals the proportion of true "yes" responses (p_1) plus a guessing factor (p_0) modified by the opportunity for guessing $(1-p_1)$. The beauty of this high-

threshold theory is that, if it is correct, the influence of spurious "yes" responses can be eliminated, the proportion of true "yes" responses being left. The familiar correction for chance success

$$p_1' = \frac{p_1 - p_0}{1 - p_0} \tag{2}$$

is a rearrangement of Eq. 1. The correction serves to normalize the psychometric function so that, whatever the observer's tendency to guess, the stimulus threshold can be taken as the signal energy corresponding to $p_i' = 0.50$.

However, the theory does not agree with the data. The empirical curve shown in Fig. 4, like the great majority of operating-characteristic curves that have been obtained, is not adequately fitted by a straight line. The horizontal line in Fig. 2, which follows from this theory, does not fit the second-choice data shown there. The rating data of Fig. 3 also indicate ordering of values of sensory excitation below a p_0 of approximately zero. Further, yes-no and forced-choice thresholds calculated from this theory are not consistent with each other (15).

Luce's low-threshold theory. Luce has suggested that a sensory threshold may exist at a somewhat lower level relative to the distribution of noisethat is, that p_0 may be substantial. Apart from this, the low-threshold theory is like the high-threshold theory, only twice so. Whereas Blackwell's theory permits the observer to say "yes" without discrimination when the sensory excitation fails to exceed the threshold, Luce's theory also permits the observer to say "no" without discrimination when the sensory excitation does exceed the threshold. Thus the operating-characteristic curve of this theory contains two linear segments, as shown in Fig. 5. Again, the data for observer 1 in Fig. 1 are shown for comparison. The location of the threshold indicated by these data is shown in the insert at lower right.

It may be seen that the two-line curve fits the yes-no data reasonably well, perhaps as well as the nonlinear curve of detection theory. Although the calculations have not been performed, it seems probable that this theory will also be in fairly good agreement with the second-choice data of Fig. 2. It provides for two categories of sensory excitation, and two categories would seem sufficient to produce a proportion of correct second choices significantly

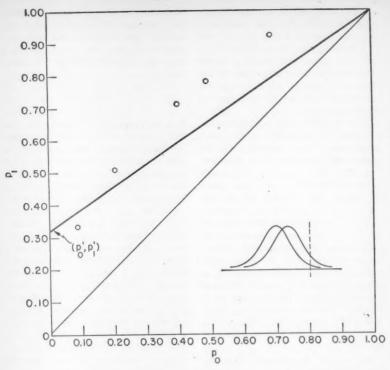


Fig. 4. The results of a yes-no experiment, and a theoretical function from Blackwell's high-threshold theory.

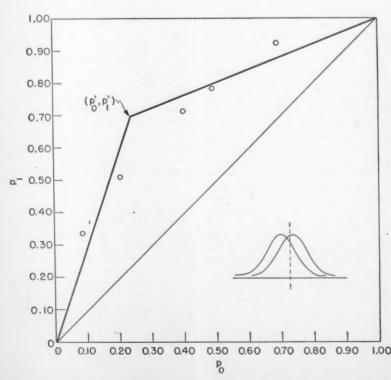


Fig. 5. The results of a yes-no experiment, and a theoretical function from Luce's low-threshold theory.

above the chance proportion. However, on the face of it, a two-category theory is inconsistent with the six categories of sensory excitation indicated by the rating data of Fig. 3. (We may note in passing that the theory raises the interesting question of how another threshold, the one above which a more complete ordering exists, might be measured.)

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Green's two-threshold theory. Green has observed that operating-characteristic data, perhaps adequately fitted by Luce's curve of two segments, are certainly better fitted by a curve with three linear segments. This curve, shown in Fig. 6, corresponds to a theory that includes a range of uncertainty between a lower threshold, below which lies true rejection, and an upper threshold, above which lies true detection. The insert at lower right shows the location of the two thresholds.

As is evident from Fig. 6, the curve of three line segments fits the yes-no data at least as well as the nonlinear curve of detection theory. Again, the calculations have not been performed, but it seems very likely that a three-category theory can account for the second-choice data. Even a three-category theory, however, is inconsistent with the six categories of sensory excitation indicated by the rating data.

There is, of course, no need to stop at two thresholds and three categories. A five-threshold theory, with a curve of six line segments, would fit any operating-characteristic data very well indeed and would also be entirely consistent with the second-choice and rating results. However, such a theory is irrelevant to the question under consideration. It is hardly a threshold theory in any important sense. It may be recalled that we considered it earlier as a variant of detection theory.

Swets, Tanner, and Birdsall's lowthreshold theory. Tanner, Birdsall, and I proposed a threshold theory that may be described as combining some of the features of Blackwell's and Luce's theories. This theory permits ordering of values of sensory excitation above the threshold but locates the threshold well within the noise distribution. The corresponding operating-characteristic curve is composed of a linear segment above some substantial value of po (say, 0.30 to 0.50) and a curvilinear segment below this value. Inspection of Fig. 1 shows that such a curve fits yesno data rather well. It is evident that the second-choice data, and rating data exhibiting six categories, could also be obtained without ordering below this threshold.

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Stevens' quantal-threshold theory. The quantal-threshold theory advocated by Stevens cannot be treated on the same terms as the other threshold theories. The data of Figs. 1, 2, and 3 are not directly relevant to it. The reason is that, whereas the other threshold theories give a prominent place to noise, collection of data in accordance with the quantal theory requires a serious attempt to eliminate all noise, or at least enough of it to allow the discontinuities of neural action to manifest themselves.

We may doubt, a priori, that noise can in fact be reduced sufficiently to reveal the "grain" of the action of a sensory system. Although the other theories we have examined apply to experiments in which the noise is considerable and, as a matter of fact, are typically applied to experiments in which noise (a background of some kind) is added deliberately, they are not generally viewed as restricted to such experiments. In adding noise we acknowledge its universality. The assumption is that the irreducible minimum of ambient noise, equipment noise, and noise inside the observer is enough to obscure the all-or-none quality of individual nervous elements in a psychological experiment. Noise is added in order to bring the total, or at least that part of it external to the observer, to a relatively constant level, and to a level at which it can be measured.

A recent article reviewing the experiments that have sought to demonstrate quantal threshold has questioned whether any of the experiments suffices as a demonstration (19). Even if we ignore some technical questions concerning curve-fitting procedures and grant that some experiments have produced data in agreement with the quantal-threshold theory, we must observe that obtaining such data evidently depends upon the circumstance of having elite experimenters as well as elite observers (18). A relatively large amount of negative evidence exists; several other experimenters have attempted to reproduce the conditions of the successful experiments without success (19).

A striking feature of the quantaltheory experiments, in the present context, is the stimulus-presentation procedure employed. Although not contingent upon anything in the theory,

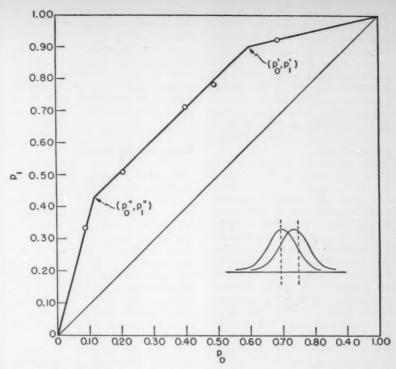


Fig. 6. The results of a yes-no experiment, and a theoretical function from Green's two-threshold theory.

the recommended procedure is to present signals of the same magnitude on all the trials of a series and to make known to the observer that this is the case. This procedure provides an unfortunate protection for the theory; if the observer is likely to make noisedetermined "yes" responses, the fact will not be disclosed by the experiment. Licklider has expressed aptly the growing discomfiture over this procedure: "More and more, workers in the field are growing dissatisfied with the classical psychophysical techniques, particularly with the [methods that ask the observer) to report 'present' or 'absent' when he already knows 'present.' It is widely felt that the 'thresholds' yielded by these procedures are on such an insecure semantic basis that they cannot serve as good building blocks for a quantitative science" (20). Although the original intent behind the use of this procedure in the quantal-theory experiments was to make the task as easy as possible for the observer, from the point of view of detection theory the procedure presents a very difficult task-it requires that the observer try to establish the response criterion that he would establish if he did not know

that the signal was present on every

Thus the advocates of the quantal theory specify a procedure that makes detection theory inapplicable. The result is that, as things stand, the conflict between the two theories cannot be resolved to the satisfaction of all concerned, as it conceivably could be if both theories could be confronted with the same set of data. However, there is reason to hope—since the quantal-theory procedure is not intrinsic to the theory but rests rather on a sense of experimental propriety, which is a relatively labile matter—that such a confrontation will some day be possible.

Is There a Sensory Threshold?

We have considered the data of three experiments—the yes-no, second-choice, and rating experiments—in relation to five competing theories concerning the processes underlying these data. The three sets of data are in agreement with detection theory, a theory that denies tine existence of a sensory threshold, and also with the version of a low-threshold theory proposed by Tanner,

Birdsall, and me. Blackwell's highthreshold theory is inconsistent with all three sets of results. Luce's low-threshold theory is consistent with the first. perhaps consistent with the second, and inconsistent with the third. Green's twothreshold theory fits the first two sets of results but not the last. We also considered the only other explicit threshold theory available-the quantal theory, to which the three experiments are not directly relevant.

The outcome is that, as far as we know, there may be a sensory threshold. The possibility of a quantal threshold cannot be discounted, and certainly not on the basis of data at hand. On another level of analysis, there may be what we have termed a low threshold, somewhere in the vicinity of the mean of the noise distribution. The low-threshold theory proposed by Tanner, Birdsall, and me fits all of the data we examined. If the rating experiment can be dismissed (there is now no apparent reason for giving it less than full status), then Luce's and Green's theories, which involve a low threshold, fit the remaining data.

On the other hand, the existence of sensory threshold has not been demonstrated. Data consistent with the quantal theory are, at best, here today and gone tomorrow, and the theory has yet to be tested through an objective procedure. With respect to a low threshold, we may ask whether demonstration of such a threshold is even conceivable.

It is apparent that it will be difficult to measure a low threshold. Consider the low-threshold theory that permits complete ordering above the threshold in connection with the forced-choice experiment. The observer conveys less information about his ordering than he is capable of conveying if only a first choice is required. We saw in the preceding discussion that the second choice conveys a significant amount of information. Another experiment, in which the observer tried to be incorrect, indicated that he can order four choices (6). Thus it is difficult to determine when enough information has been extracted to yield a valid estimate of a low threshold.

Again, it is difficult to imagine how one might determine the signal energy corresponding to the thresholds of Luce's and Green's theories. The determination is made especially difficult by the fact that, in general, empirical operating-characteristic curves for various signal energies are fitted well by the theoretical curves of detection theory. Consequently, the line-segment curves that best fit the data have lines intersecting at a value of po that depends upon the signal energy. The implication is that the location of the threshold depends on the signal energy that is being presented.

Implications for Practice

We have, then, the possibility of a threshold, but it is no more than a possibility, and we must observe that since it is practically unmeasurable it will not be a very useful concept in experimental practice. Moreover, even if the low threshold proposed by Tanner, Birdsall, and me did exist, and were measurable, it would not restrict the application of detection theory. We may note that yes-no data resulting from a suprathreshold criterion depend upon the criterion but are completely independent of the threshold value. The same limitation applies to the quantal threshold. It appears that a compelling demonstration of this concept will be difficult to achieve, so that in practice a theory and a method that deal with noise will be required.

Accordingly, with any attempt to measure sensitivity by means of "yes" and "no" responses, a measure of the observer's response criterion should be obtained. The only way known to obtain this measure is to use catch trialsrandomly chosen trials that do not contain a signal. The methods of adjustment, limits, and constants in their usual forms, in which the observer knows that the signal is present on every trial, are inappropriate.

A large number of catch trials should be presented. It is not sufficient to employ a few catch trials, enough to monitor the observer, and then to remind him to avoid "false-positive" responses each time he makes one. This procedure merely forces the criterion up to a point where it cannot be measured, and it can be shown that the calculated threshold varies by as much as 6 decibels as the criterion varies in this unmeasurable range (5). Precision is also sacrificed when, because highly trained observers are employed, the untestable assumption is made that they do maintain a constant high criterion. Even if all laboratories should be fortunate enough to have such observers, we would have to expect a range of variation of 6 decibels among "constant criterion" observers in different laboratories. To be sure, for some problems, this amount of variability is not bothersome: for others it is.

The presentation of a large number of catch trials-enough to provide a good estimate of the probability of a 'ves" response on such a trial—is still inadequate if this estimate is then used to correct the proportion of "yes" responses to the signal for chance success. The validity of the correction for chance depends upon the existence of a high threshold that is inconsistent with all of the data that we examined. It should be noted that the common procedure of taking the proportion of correct responses that is halfway between chance and perfect performance as corresponding to the threshold value of the signal is entirely equivalent to using the chance correction.

In summary, in measuring sensitivity it is desirable to manipulate the response criterion so that it lies in a range where it can be measured, to include enough catch trials to obtain a good estimate of this response criterion, and to use a method of analysis that yields independent measures of sensitivity and the response criterion. One qualification should be added: We can forego estimating the response criterion in a forced-choice experiment. Under the forced-choice procedure, few observers show a bias in their responses large enough to affect the sensitivity index d' appreciably. Those who do show such a bias initially can overcome it with little difficulty. As a result, the observer can be viewed as choosing the interval most likely to contain a signal, without regard to any criterion. For this reason, the forced-choice procedure may be used to advantage in studies having an emphasis on sensory, rather than on motivational or response, processes (21).

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References and Notes

- G. T. Fechner, Elemente der Psychophysik (1860).
- (1860).

 2. The general theory of signal detectability is presented in W. W. Peterson, T. G. Birdsall, W. C. Fox, IRE Trans. Profess. Group on Information Theory PGIT-4, 171 (1954). Psychophysical theories similar to it have been suggested by M. Smith and Edna A. Wilson, Psychol. Monographs 67, No. 9, Whole No. 359 (1953), and W. N. Munson and J. E. Karlin, J. Acoust. Soc. Am. 26, 542 (1956). The first application of detection theory in psychophysics is described in W. P. Tanner, Jr., and J. A. Swets, Psychol. Rev. 61, 401 (1954).

 3. E. G. Boring, A History of Experimental Psychology (Appleton-Century-Crofts, New York, ed. 2, 1950), p. 284.

 4. E. G. Boring, The Physical Dimensions of Consciousness (Century, New York, 1933).

- .5. J. A. Swets, W. P. Tanner, Jr., T. G. Birdsall, "The evidence for a decision-making theory of visual detection," Electronic Defense Group, Univ. Michigan, Tech. Rept. No. 40 (1955). This material will appear as "Decision processes in perception," Psychol.
- 6. W. P. Tanner, Jr., J. A. Swets, D. M. Green, "Some general properties of the hear-ing mechanism," Electronic Defense Group, Univ. Michigan, Tech. Rept. No. 30 (1956).

W. P. Tanner, Jr., and J. A. Swets, Psychol. Rev. 61, 401 (1954).
 J. A. Swets, J. Acoust. Soc. Am. 31, 511

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(1959). J. P. Egan, A. I. Schulman, G. Z. Green-berg, ibid. 31, 768 (1959). W. P. Tanner, Jr., and R. C. Jones, "The ideal sensor system as approached through statistical decision theory and the theory of signal detectability," proceedings of the Armed Forces-NRC Vision Committee meeting, Washington, D.C., Nov. 1959.
 W. P. Tanner, Jr., and T. G. Birdsall, J. Acoust. Soc. Am. 30, 922 (1958).
 J. A. Swets, E. F. Shipley, M. J. McKey, D. M. Green, ibid. 31, 514 (1959).
 W. W. Peterson, T. G. Birdsall, W. C. Fox, IRE Trans. Profess. Group on Information Theory PGIT-4, 171 (1954).
 D. M. Green, J. Acoust. Soc. Am. 32, 1189 (1960).

(1960).

15. H. R. Blackwell, "Threshold psychophysical unpublished. Also, Univ. measurements."

Mich. Eng. Research Inst. Bull. No. 36 (1953). R. D. Luce, Science 132, 1495 (1960).

(1953).

16. R. D. Luce, Science 132, 1495 (1966).

17. D. M. Green, personal communication.

18. S. S. Stevens, in Sensory Communication,

W. A. Rosenblith, Ed. (Technology Press

W. A. Rosenblith, Ed. (Technology Press);

S. S. Stevens, in Sensory Communication, W. A. Rosenblith, Ed. (Technology Press and Wiley, New York, in press); ——, Science 133, 80 (1961).
 J. F. Corso, Psychol. Bull. 53, 371 (1956).
 J. C. R. Licklider, in Psychology: A Study of Science, S. Koch, Ed. (McGraw-Hill, New York, 1959), vol. 1.
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Science and the News

Hanford and Stanford: The Issue Is Clear but the Politics Are Complex

The complicated politicking that has linked a \$95 million proposal to add power generating facilities to the new Hanford, Washington, plutonium reactor and the \$114 million proposal to build a giant electron accelerator at Stanford University grew even more complicated last week when the House of Representatives knocked the Hanford proposal out of the Atomic Energy Commission authorization bill. The House defeat set in motion an elaborate stratagem by supporters of Hanford to save the project, and the stratagem, until nearly the last minute, involved a threat to kill the Stanford accelerator, although this move was finally abandoned.

The Hanford proposal involves building a generating plant to use the steam produced by the cooling system of the plutonium reactor. If built, it would produce 700,000 kilowatts of power, and would be the largest atomic power plant in the world. Heavy opposition developed from the private power industry, which was immensely displeased at the idea of the government's going into the production of atomic power, and from the coal industry and coal-producing areas generally, which felt that if the Hanford plant were not converted to

power production, new coal-fired generating plants would be built to provide for the Northwest's power needs. One West Virginia Democrat from a coal-mining area who had a nearly perfect record of support for the Administration took the floor to dissociate himself from the arguments of the opponents of public power. He said his vote would simply reflect the fact that he was representing West Virginia, not the whole United States, and that he could not vote for a proposal that would, he feared, just put more West Virginians on the dole.

In the Pacific Northwest, on the other hand, conservative Republicans joined the Democrats in supporting the proposal, and the strongly conservative Portland Oregonian, after the House vote, published a bitter editorial railing at the "incredible piece of Congressional stupidity" based on "arguments as phony as a lead wedding ring."

The debate, then, was essentially over the issue of an expansion of public power, but with many departures from normal voting patterns, based on sectional interests.

Democrats on the Atomic Energy Committee hoped to save the proposal after the House defeat by restoring the Hanford authorization in conference, with the chance that the conference report might be pushed

through the House. This was the tactic that enabled the Administration to get through its minimum wage bill after a preliminary defeat in the House.

A conference report is supposed to represent a compromise between rival House and Senate bills. To create at least an illusion of something that could be compromised between the House and Senate, the Democrats talked of knocking some provision out of the bill in the Senate. The conference committee, controlled by supporters of Hanford, could then arrange a "compromise" in which the House would give in on Hanford and the Senate would graciously restore whatever it had knocked out. Since the Stanford accelerator was the only project in the bill even remotely comparable in importance to Hanford, the Democrats planned to try to kill Stanford in the Senate.

This was a peculiarly transparent scheme since the same Democratic Senators who as members of the Joint Atomic Energy Committee had unanimously voted in favor of Stanford would now have to take the floor of the Senate to argue that it should be killed. But it was seriously talked about, privately of course, by leading members of the Joint Committee up until the day before the Senate vote last Tuesday. and apparently finally abandoned only when it became clear that there was no way to get a majority of the Senate to go along with it.

Last Tuesday, opponents of Hanford in the Senate, led by Hickenlooper of Iowa, fought hard to kill the Hanford project then and there by knocking it out of the Senate version, thus leaving no chance for it to be restored in conference. But after 3 hours of debate supporters of the project carried the vote by 54 to 36. This left Hanford in in the Senate version, out in the House, and with a majority in the conference committee prepared to put it back in the final bill. But whether the House can be induced to accept such a conference report is most doubtful. Meanwhile, final authorization of the \$114 million for the Stanford accelerator now had become assured.

Satellite Communications

There is a rough analogy between the problems of public versus private power that led to the Hanford controversy and the question of proper ownership of a satellite communications system. Last month the President asked the Space Council for recommendations on the "nature and diversity of ownership of a world-wide communications system," with the proviso that "public interest considerations should be given the highest priority." This request formally reopened the question of ownership. The Eisenhower Administration, in one of its last policy directives before it left office, had announced that "the government should aggressively encourage" commercial development of a satellite communications system.

The new Administration has laid great stress on the necessity for making the service available to all countries, an obvious point of conflict with the commercial interest in concentrating on the profitable, high-traffic ties between North America and Western Europe. Another potential point of conflict was brought up by the testimony of Edward R. Murrow last week before the House Science Committee. Murrow, head of the United States Information Agency, talked of the importance of the system to the information program. Satellite communications, for example, will make world-wide television broadcasting a reality, and Murrow stressed the need to see that the rates charged USIA under such a system will be low enough to permit the agency to make extensive use of the system. Murrow argued that a low rate for government agencies is well justified by the heavy public investment that is making the system possible, but there is a clear conflict here with the commercial interest in limiting the amount of lowrate government traffic in order to maximize the amount of commercial traffic that can be carried.

The problem, then, is whether the commercial companies can profitably make the heavy investments necessary to create the system, to do this as quickly as the Administration feels the

national interest demands, and to do it under the handicap, for commercial investors, of having to design a system that includes a number of features, only two of which are noted above, which make no sense from a commercial point of view, but which may make very good sense from a national point of view. There is a good deal of doubt within the Administration that a commercial venture can meet these requirements. Nevertheless, for the government to announce an intention to own the system, and hence to pre-empt commercial development, would raise a controversy that would dwarf the squabble that developed over the Hanford atomic power plant.

The Space Council this week submitted its recommendations on this touchy matter to the President. A public announcement will be made sometime after the report is approved by the President. Unless major changes are made, which is unlikely, the policy to be laid down will be the politically obvious one of (i) stating a preference for private development in keeping with the traditional way of handling things in this country, (ii) stressing that the national interest remains paramount and that no proposal can be accepted that fails to meet the national interest, and (iii) stressing that speed of development is an urgent factor.

In effect, this is a policy of hedging: a real decision on the ownership of the system will have to be made fairly early in 1962. For the time being the Administration's policy will be to give the commercial companies a chance to get together and see what kind of proposal they can come up with, for even those within the Administration who are strongest in their feeling that the system will have to be developed by the government recognize that as a matter of practical politics the commercial companies cannot be shut out of the ownership arrangement until they at least have been given a chance to make a proposal.

Science Advisers

On another policy matter on which the Administration is in no rush to commit itself, a proposal of Senator Jackson's subcommittee on National Policy Machinery to reorganize the President's Science Advisory Committee (PSAC) has been greeted with discreet silence. The Jackson subcommittee's staff report suggested that there is no present need for a Department of

Science, but that the PSAC ought to be removed from the President's personal staff, expanded, and formally organized as an agency roughly equivalent to the Council of Economic Advisers, which has formal responsibility for studying national economic policy. In practice, the PSAC already has equivalent responsibility for overall science policy, and the changes recommended by the Jackson subcommittee are rather technical in nature. Nevertheless, they would significantly alter the role of the PSAC.

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At present the committee has no formal basis for its existence. Its budget comes out of a fund for the President's office expenses for which no accounting is made to Congress. It is merely part of the President's personal staff, and it could be disbanded at the pleasure of the President, but it has assumed an important enough role so that it is unthinkable that it should be disbanded. It is PSAC's very importance that has led to occasional congressional criticism that it is not only completely beyond the control of Congress but that, as a body whose only responsibility is to the President personally, it is completely beyond the power of Congress to even find out just what it is doing.

The Jackson committee's recommendations would shift the PSAC from the White House staff to the much larger organization known as the Executive Office of the President, and would require the appointment of two associates to the present science adviser, thus paralleling the three-man Council of Economic Advisers.

The essential argument of the Jackson committee was that the need for a high-level science policy agency is so clear that it seemed a good idea to have it formally organized and formally given its responsibilities. But the clearest effect of the recommendations would be to open up the PSAC to limited congressional surveillance, if only through the device of making the advisers appear before congressional committees to justify their budget.

As a result, the Administration has shown little interest in the proposal, for it is good administrative practice to avoid setting up a new agency until a need for a new agency has become clear. And no administration is particularly delighted with the idea of reorganizing something if the principal immediate effect will be merely to give the legislative branch more power over it.—H.M.

News Notes

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Space Science Abroad

A number of nations, other than the United States and Russia, have been making news in space developments.

West Germany has agreed to join with 11 other European nations in preparing space probes. France and Great Britain initiated the European space venture, which will cost an estimated \$196 million over a 5-year period. The other nations participating are Italy, Switzerland, Austria, Norway, Denmark, Sweden, Belgium, the Netherlands, and Spain.

In early negotiations, the Germans had agreed to help out in the research required but had refused to contribute funds or materials. Bonn's reluctance to be actively committed was attributed to apprehension that the United States might resent German involvement in a project that could establish Western Europe as a third competitor in the race for space. The U.S., however, has consistently supported and encouraged all western European efforts to advance space capability; and economic considerations are believed to have been the major factor behind Germany's hesitation. West German partnership is essential to the multination space effort since that nation's share of the cost is to be 18 percent; 20 percent of the funds are to be provided by France and 33 percent by Great Britain. Germany's continued refusal would have seriously limited the program and might perhaps have doomed it.

Western Europe

The western European nations, with the exception of Austria, also have reached a preliminary agreement to set up a European Space Research Organization for constructing and launching a satellite. A commission has been appointed to organize and plan the research program.

Among the projects proposed are establishing a base for high-altitude rockets in the aurora borealis zone, studies of the upper atmosphere and interplanetary space with rockets and small satellites, and studies of the moon and its environment from a large satellite in orbit around the moon. Britain's Blue Streak rocket will probably be used as the first stage of the booster for the satellite launching, France's Veronique for the second; no decision has

been reached about the third stage. The Blue Streak, a liquid-fuel rocket, was originally developed as an intercontinental ballistic missile. The Veronique has been used to launch biological experiments; earlier this year it was used to shoot a rat into the upper atmosphere.

Another cooperative development in space with South American participation also took place recently when representatives from Brazil met in Paris with officials from France, Britain, West Germany, and the United States to discuss cooperation in a proposed test program for an international communication satellite system. If negotiations are successful, the program will start next year with the launching of two communication satellites by the United States. France will aid in the test with an experimental center in Brittany participating; and a ground radio station will be set up by Great Britain on Lizard Head, in the southwestern tip of England, for the transatlantic portion of the experiment.

National Efforts

Individual nations also are working to develop national capabilities in space, and the United States is helping. Earlier this year France and the United States joined in a memorandum of understanding on space research. Experiments to be prepared by France to study radio wave propagation, aurora and airglow, and space biology will be launched by the National Aeronautics and Space Administration with sounding rockets from Wallops Island, Virginia. Britain is working on a satellite for ionospheric research to be launched next year from Wallops Island with a Scout booster. Two-stage, solid-fuel sounding rockets also have been built and launched by Australia and Canada.

Italy plans to launch a rocket early this fall to test instruments for getting information from space. In April, Italy had three successful rocket launches, aided by the National Aeronautics and Space Administration. These released sodium vapor for upper atmosphere studies. Optical observation of the chemical cloud provides scientific information on wind velocity, density, temperature, and turbulence in the upper atmosphere.

There has been speculation that Italy also may attempt to orbit a small satellite. This has been officially denied; but the rumors persist and stem from the fact that Italy has been involved recently in discussions with Great Britain and France for a satellite launching using Great Britain's Blue Streak rocket.

Sweden also is getting into the space business and has announced plans to fire meteorological research rockets from Lapland. One or two of five Arcas rockets developed by the U.S. Navy for low altitude weather studies and given to Sweden by NASA will be used as part of a series of tests being carried out by the International Meteorological Institute in Stockholm to investigate the phenomena of noctilucent clouds. These clouds appear at certain times in latitudes near the Arctic Circle and are visible at night. The Swedish space researchers hope to obtain some of the material of the clouds to determine what it is and how and where the clouds originate.

Israel became the eighth nation in the world and the first nation in the Middle East to demonstrate native space capability with the launching of the Shavit (Comet) II, a multistage, solid-fuel rocket. The other nations are Australia, Canada, France, Great Britain, Japan, the U.S.S.R., and the United States

Designed and built by Israeli scientists and technicians and made from materials native to Israel, the 560-pound booster was fired from a site on the Mediterranean coast to an altitude of 50 miles to get information about the upper atmosphere. The scientific nature of the rocket was underscored by the fact that it had no guidance or radio system. Optical observations were made of the vapor trail from metallic sodium discharged from the nose of the rocket when it reached its final stage.

The government of Israel said the Shavit II developed from the 1957–58 International Geophysical Year, in which Israel was a participating member, and announced that the results of the probe will be made available to "scientific institutions abroad with which Israel is in constant contact."

Israeli scientists and institutions have been working under U.S. grants on basic research projects, some in upper-atmosphere research but none involving rocket technology. France and Israel have worked closely together in areas involving atomic research; and it is believed that French economic aid may have helped the Israeli project.

Israel's exclusive claim to space fame among the nations of the Middle East may be short-lived. Export licenses have been issued by the State Department for the sale of research rockets

to the United Arab Republic by private U.S. manufacturers. The U.A.R. has given assurances that the rockets will be used strictly for scientific probes in the upper atmosphere like the one made by Israel. The proposed shots will release a sodium vapor trail in upper altitudes. Some weeks ago, prior to the Israeli rocket launch, the U.A.R. tried to get rockets through NASA in time for a scientific firing this month. The U.A.R. was told by NASA that a try for a space shot of scientific value on such short notice was not practicable, but the space agency indicated interest in working with Cairo on a space program with a longer time span. NASA's program with Italy has taken a year to become operational. In the Italian program the Italians bought Nike-Asp and Nike-Cajun rockets from American manufacturers, and NASA supplied technical and scientific help in addition to the sodium vapor payloads used. The rockets to be bought by the U.A.R. are like those used in the Italian firings and in U.S. experiments at Wallops Island on Virginia's eastern shore. Israel has not approached NASA for rockets. She has scheduled another Shavit launching later this month.

In the Far East, Japan is the only nation that has built and launched rockets. She has developed Kappa, a two-stage, solid-fuel sounding rocket, several of which have been launched. Positive ion and electron densities in the ionosphere, as well as cosmic radiation, have been measured.

Red China has been asking for rockets from the U.S.S.R., but so far the U.S.S.R. has not shared its knowledge or equipment with other nations of the communist bloc.

Red Blood Vessels

The Russians recently developed a machine that makes plastic artificial blood vessels (see cut) from 4 to 20 millimeters in diameter. The machine resulted from the successful experience of a Leningrad surgeon who used plastic tubing in an emergency operation to replace a damaged artery in the armpit of a patient, thereby saving the man's arm.

Soviet surgeons suture the artificial vessels to living tissue with a surgical stapler they have designed; the staples are made of tantalum and cobalt alloys.

The manufacture and use of artificial arteries in the United States dates back



Samples of various sizes of artificial blood vessels made of lavsan, a synthetic fiber similar to Dacron, manufactured by a special machine designed at the Leningrad Institute for Research for Medical Instruments and Apparatus. [United Press International]

to 1952, but the Soviet stapling technique for body repair work is an innovation. The technique was recently demonstrated before surgeons in Washington by the Russian surgical and engineering teams that developed it. The Russians claim the staplers can give an ordinary surgeon the skill of a master. U.S. surgeons generally have admired the engineering of the devices but do not consider them a substitute for surgical skill. About 12 of the stapling units have been ordered by U.S. institutions, among them Johns Hopkins, Sloan-Kettering, and Miami University.

Six-Year Program for Physicians

Twenty-five students have been selected for a new 6-year medical training program for an M.D. degree to begin at Northwestern University this fall.

Under the plan, students will take 2 years of premedical work in the liberal arts departments, but the courses will concentrate heavily on the basic sciences. The remaining 4 years will consist of the regular program of study in Northwestern's medical school. A similar program is underway at Boston University.

The minimum requirements for ad-

mission to a medical school in the United States are 3 years of university studies, including certain specified science courses; but in most cases medical students have completed 4 years in college and have a B.A. or B.S. degree. In no other country except Panama and Lebanon are more than 2 years of premedical college education required; the majority require only 1 year.

Professional medical groups in the U.S. generally have been opposed to cutting the requirements for an M.D. and have said that during the war years attempts to shorten programs often resulted in poorly trained physicians.

Proponents of the shorter premedical training period say that it in no way deprives the student of his professional studies and that it may, in fact, make a career in medicine more attractive to the gifted science student, now attracted to other scientific fields where he can establish himself more swiftly and easily. In general the program is aimed at reducing the high cost, in both time and money, of a medical education, which has contributed to the growing shortage of physicians.

Paralytic polio cases in the United States continue to decline. In 1955, the year the Salk vaccine was approved for use, 13,850 cases were reported. There

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were 7911 cases in 1956; 2499 in 1957; 3697 in 1958; 6289 in 1959; and 2265 last year.

The rise in 1958 and 1959 is attributed by the Public Health Service to a series of localized outbreaks, mainly in slum sections of urban areas populated by low-income groups; most of the polio victims had not received the Salk shots. A concerted effort was made to provide free Salk vaccine to these income groups in time to protect them from the disease last year and this year. The number of cases reported up to 1 July is 237, whereas 469 cases were reported during the first half of 1960.

Prior to the use of Salk vaccine, polio incidence in the United States was much higher in the higher income groups. The lower level of incidence among the poorer members of the population was attributed to a natural immunity resulting from more frequent exposure to the disease.

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A bill to consolidate and strengthen the various cultural and educational exchange programs that began with the establishment in 1944 of the Fulbright scholarships easily passed the Senate. About \$30 million a year is now being spent on the programs. Senator Dirksen of Illinois, opposing the bill, called it a sort of "world federal aid to education" paralleling the Administration's school aid bill. Senator Fulbright, now chairman of the Foreign Relations Committee and floor manager of the bill, said he was in favor of both programs, but that \$30 million didn't go very far when spread around the world, and that the United States, in its own interest, ought to be spending more. Dirksen said he was afraid that was just what was going to happen if the bill was passed. But Dirksen, and most others who criticized the bill, aimed only to limit its scope, not to defeat the program. On the final vote only Senators Goldwater, Tower (R-Tex.) and three of the most conservative Southerners opposed the bill. The vote was 79 to 5. The House version of the bill is still in the Foreign Affairs Committee, which will act later in the month, after it has completed work on the foreignaid bill.

The Joint Committee on Atomic Energy will hold public hearings next week on developments in detection and identification of nuclear explosions underground and in outer space.

Announcements

The United States will make nuclear equipment costing \$80,000 available to the International Atomic Energy Agency, Vienna, to assist atomic energy projects in Argentina, Brazil, and Israel through the agency's technical assistance program. Argentina will receive a mass spectrometer ion source and an electron paramagnetic resonance spectrometer, Brazil will receive equipment for research in the use of isotopes in agriculture, and Israel will receive monitoring stations for use in the area surrounding its research reactor at Rehovot.

The committee of judges for the 1961 AAAS Theobold Smith award [Science 133, 2003 (23 June 1961)] consists of:

Thomas Butler, University of North Carolina School of Medicine.

Jacob Furth, Roswell Park Memorial Institute, University of Buffalo.

Francis D. Moore, Harvard Medical School.

Maxwell M. Wintrobe, University of Utah College of Medicine.

John B. Youmans, American Medical Association, chairman.

Nominations, which must be received before 1 September, may be sent to Oscar Touster, Department of Biochemistry, Vanderbilt University School of Medicine, Nashville 5, Tenn.

A bibliography of interlingual scientific and technical dictionaries has been published for scientists and technicians engaged in work outside their own countries. The UNESCO publication, aimed at the standardization of scientific terminology, covers 350 subjects. (UNESCO Publications Center, 801 3rd Ave., New York)

Photographers and scientists are invited to submit scientific and technical photographs for consideration for inclusion in a 16-page insert in the McGraw-Hill Yearbook of Science and Technology. (John T. Westlake, McGraw-Hill Book Co., 10 Elliewood Ave., Charlottesville, Va.)

A new faculty fellowship program will be inaugurated next fall at Dartmouth College that will allow two to five faculty members to devote a year to research or other scholarly and creative activities. Recipients will re-

ceive their regular full compensation and a grant of up to \$2500 for travel and other expenses related to their work. The fellowships, available to assistant, associate, and full professors, will supplement the college's regular sabbatical leave program and outside awards and fellowships.

The Johns Hopkins School of Hygiene has received a \$250,000 grant from the State Department for the improvement of foreign aid health programs during the next 3 years.

Samples of unsaturated fatty acids are available to qualified investigators through the National Institutes of Health lipid program. A brief description (in duplicate) of the research program for which the samples are to be used should accompany each request. (William H. Goldwater, Division of Research Grants, NIH, Bethesda 14, Md.)

A selected reading list on space flight has been compiled by the Bell Telephone Laboratories' Technical Information Library. (Space Flight, Bell Telephone Laboratories, 463 West St., New York 14)

Meeting Notes

An international symposium on photoelasticity will be held 29–31 October at Illinois Institute of Technology. The program will cover photoelasticity, photoplasticity, photothermoelasticity, dynamic photoelasticity, and special equipment. (M. M. Frocht, Illinois Institute of Technology, Technology Center, Chicago 16)

An international conference on nuclear physics will be held at Manchester University, England, 4-8 September. The conference is sponsored jointly by the university, the International Union of Pure and Applied Physics, the Royal Society, and the Institute of Physics and the Physical Society.

A food science conference will be held 19-22 September at the Food Preservation Research Laboratories, New South Wales, Australia. The conference, sponsored by the Commonwealth Scientific and Industrial Research Organization, is open to scientists, technologists, and managerial staff from the food industry and food re-

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search laboratories. (Chief, CSIRO Division of Food Preservation, P.O. Box 43, Ryde, N.S.W., Australia)

The British Association for the Advancement of Science will hold its 123rd meeting in Norwich, Norfolk, England, 30 August-6 September. The main program is arranged in 15 sections, covering almost every field of science. A number of complimentary tickets are available for overseas science students. (Secretary, BAAS, 18 Adam St., London, W.C.2)

A meeting on smoking and lung cancer and associated questions will be conducted as part of the 33rd session of the International Statistical Institute, to be held in Paris, 28 August–7 September. The main papers and the discussion will be published in the Bulletin de l'Institut International de Statistique. (Joseph Berkson, Mayo Clinic, Rochester, Minn.)

The first National (Mexican) Congress of Anatomy, sponsored by the Mexican Society of Anatomy, will be held in Mexico City 10–14 September. United States anatomists are invited to attend. (Fernando Quiroz Pavia, Admon de Correos 70, Apartado No. 25279, Mexico 20, D.F., Mexico)

The Pan American Association of Ophthalmology will hold an interim congress in Lima, Peru, 28 January—3 February 1962. The congress will include a round table in diagnosis and nonsurgical therapy of glaucoma; a symposium on steroid therapy; and individual papers on the cornea. Postgraduate courses will be given in English, Spanish, and Portuguese. Simultaneous translations will be available during discussions. Deadline: 30 October 1961. (John M. McLean, 525 E. 68 St., New York 21)

Scientists in the News

Paul C. Cross, professor and executive officer of the University of Washington's department of chemistry, has been named president, chief executive officer, and a trustee of the Mellon Institute.

Winston K. Shorey, interim associate dean of the University of Miami's School of Medicine, has been appointed dean of the University of Arkansas Medical School.

Carl W. Gottschalk, associate professor of cardiology at the University of North Carolina School of Medicine, has been awarded the lifetime post of career investigator by the American Heart Association.

New members of the National Cancer Institute's Board of Scientific Counselors:

Howard E. Skipper; Southern Research Institute, Birmingham, Ala.

Richard E. Shope; Rockefeller Institute for Medical Research, New York. William U. Gardner; Yale University School of Medicine.

Hugh R. Butt of the Mayo Clinic, Rochester, Minn., will serve as the new chairman, succeeding Philip P. Cohen.

Arthur C. Allen, professor of pathology at the University of Miami Medical School, will become director of laboratories at the Jewish Hospital of Brooklyn and clinical professor of pathology at State University Medical School, Downstate Medical Center, Brooklyn, N.Y., on 1 September.

Recent additions to the Harvard University faculty:

Herman M. Kalckar, professor of biology and biochemistry at Johns Hopkins' McCollum-Pratt Institute, will become professor of biological chemistry.

Thomas E. Frothingham, assistant professor of pediatrics at the New York University School of Medicine, will become assistant professor of tropical public health.

Harold F. Parks, associate professor of anatomy at the University of Rochester School of Medicine and Dentistry, has been appointed professor of zoology at Cornell University.

Newly elected members of the Council for the Advancement of Science Writing:

Joseph Kaplan, physicist and chairman of the U.S. National Committee for the International Geophysical Year.

William P. Steven, editor of the Houston Chronicle, Houston, Tex.

Ernest G. Anderson, professor of genetics at California Institute of Technology, is retiring after 33 years as a member of the faculty.

George N. Papanicolaou, exfoliative cytologist at Cornell Medical College, has accepted the directorship of the Cancer Institute, Miami.

Carl E. Taylor, associate professor of preventive medicine and public health at Harvard, has been granted a year's leave of absence to organize a 5-year research study of rural internships in Indian medical colleges. He will be visiting professor of preventive medicine at the Ludhiana Christian Medical College in the Punjab.

Frank T. Piskur, director of the Department of the Interior's Fishery Technological Laboratory, College Park, Md., has been named assistant regional director of the Alaska office of the department's Bureau of Commercial Fisheries, Juneau.

Walter S. Bradfield, senior scientist at the General Dynamics Scientific Research Laboratory, San Diego, has been appointed professor of engineering and chairman of the department of thermal sciences and fluid mechanics at the new State University of New York.

S. K. Hoffman, president of Rocketdyne, a part of North American Aviation, Inc., and T. F. Dixon, vice-president of Rocketdyne's research and engineering division, are co-recipients of the 1960 Louis W. Hill space transportation award, administered by the Institute of Aerospace Sciences.

Recent Deaths

Charles H. Bunting, 86; emeritus professor of pathology at the University of Wisconsin, and lecturer in pathology at Yale University Medical School from 1945 to 1955; 27 May.

Joseph H. Faull, 91; emeritus professor of forest pathology at Harvard University; 30 June.

Lee de Forest, 87; inventor of the radio tube; 30 June.

H. Richard Gault, 46; professor and head of the department of geology at Lehigh University; 5 July.

Walter C. G. Kirchner, 85; member of the Jewish Hospital of St. Louis (Mo.) medical staff since 1933; 15 May.

Erratum: The first announcement in the news section of the 7 July issue (p. 39, col. 3) referred to the "American Institute of Microbiology." This should have read "American Academy of Microbiology."

Erratum: In the report "Synthesis of uracil under conditions of a thermal model of pre-biological chemistry," by S. W. Fox and K. Harada [133, 1923, 16 June 1961)], the abbreviation "dec.," meaning decomposition, was twice incorrectly expanded to "decrease." The two errors appear in the last two paragraphs of col. 2, p. 1923.

Book Reviews

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A Short History of Technology from the Earliest Times to A.D. 1900. T. K. Derry and Trevor I. Williams. Oxford University Press, New York. 1961. xviii + 782 pp. \$8.50.

As the five volumes of the monumental History of Technology gradually appeared (Oxford University Press, 1954-1958), it became clear that some type of abridgment would be highly useful, especially if such an abridgment were so designed that it could be used as the basic text in a university course on the history of technology. The present work is technically not an abridgment of the earlier volumes, but rather a completely new book which, naturally enough, relies heavily upon the earlier work. Indeed, we are told that from the very beginning of the earlier project-Williams was a coeditor of the last four volumes of the Oxford series—the need for a shorter version was recognized. Consequently, Imperial Chemical Industries Limited, financial sponsors of the original project, increased their support to make possible the book which Derry and Williams have now written.

The result is an admirable introduction to the history of technology, which should serve both the textbook purpose and the general reader. This is not to say that it is an ideal book. When we reflect on the relative novelty of the history of technology as a separate discipline, it is not difficult to understand why authors are still "feeling their way," so to speak, concerning both the importance of specific technological developments and an acceptable style, or form, for such writing. The authors point out that there are many compromises involved in attempting to present a "readable and connected account." This must be admitted, for such material cannot be displayed in its rightful richness when presented in strict chronological order,

in merely geographical order, or simply in terms of the development of first one and then another idea or invention. The innovation here attempted is to preface each section with a general historical introduction to the period under discussion so that technology may be viewed in the larger context of political, economic, and institutional factors. Such an imbedding is clearly indicated, and it is quite successfully carried out in the present

There are more than 350 illustrations, but no plates. The illustrations lack uniformity (this is understandable, since they came from a variety of sources). Some of the drawings (for example, Figs. 304 to 306) are both clear and detailed enough to have real meaning in a work such as this. Others, unfortunately, are either so crude (for example, Figs. 214 and 336), or so dark (for example, Fig. 325), or just so unhelpful (for example, Figs. 132 and 314) that one wishes more care had been devoted to their selection.

The book concludes with an excellent set of chronological tables, a selected bibliography which should be very useful, a subject index, and an index of persons and place names.

WILLIAM D. STAHLMAN Department of the History of Science, University of Wisconsin

Making Landscapes

The Finger Lakes Region. Its origin and nature. O. D. von Engeln. Cornell University Press, Ithaca, N.Y., 1961. x + 156 pp. Illus. + plates. \$4.50.

Books on American regional land forms are so few that a new one is eagerly looked for, even by geologists who, like this reviewer, have no special competence in the author's fields of geomorphology and glacial geology.

Von Engeln first describes the origin

and nature of the area's preglacial landscape: a country of slight relief except for a few north-facing steep slopes (escarpments). The largest streams flowed north. Later, during glaciation, ice moved southward, was "dammed up" against the highest escarpments, and was funneled into the major stream courses. Selectively, these valleys were widened and deepened into the imposing Finger Lake valleys of today. Glacial erosion and deposition have given us beautiful hanging valleys, waterfalls, postglacial gorges (like Watkins Glen), drumlins, and high-lake

Following these chapters on glacial processes and the resulting landscape, the author discusses the causes of glaciation in an epilogue. There is an appendix, "Vantage points and excursions," another titled "Maps," a glossary, and a brief list of references.

Local amateurs and professionals are likely to use the book to greatest advantage, so overwhelming is the amount of geographic detail. Even these readers may find the maps and diagrams inadequate by themselves, and indeed they are seldom keyed in with the text. For example, scores of names used in the text cannot be found on the principal map (pages 28 and 29). Many localities are given by mileage along a numbered state route, so a good road map is a necessity. True, there is an index of the hundred or more topographic quadrangles. I am sure that the serious reader must have many of these on hand, indoors or in the field. Again, he will find that exact localities on these quadrangles are seldom given in the text.

Most of von Engeln's ideas are current and familiar. But in the epilogue, submarine canyons are cited as proof of subaerial erosion-hence as proof that continents stood many thousands of feet higher (sea level that much lower) during glaciation than now. What implications for zoogeography!

To get the most out of this book, the "average reader" might turn first to von Engeln's own Geomorphology (1942) for an account of glaciation as a whole. The more serious reader might follow along in Flint's Glacial and Pleistocene Geology (1957) for a wider treatment of processes described in the present book. Neither of these titles is given in the brief list of refer-

LINCOLN DRYDEN

Department of Geology, Bryn Mawr College

Russian Geography

Physical Geography of Asiatic Russia.

S. P. Suslov. Translated from the Russian by Noah D. Gershevsky.

Joseph E. Williams, Ed. Freeman, San Francisco, Calif., 1961. xv + 594 pp. Illus. \$15.

The Soviet Union. The land and its people. George Jorré. Translated by E. D. Laborde. Longmans, New York, ed. 2, 1961. 372 pp. Illus. \$7.50.

When I asked a Soviet geographer to comment on the Suslov translation, he remarked that the original was a useful volume but that now, of course, it was out of date. The first edition appeared in 1947, but the translation is based on the second edition which appeared in 1956. Much of the actual translation was done by Clayton L. Dawson, under the supervision of Noah D. Gershevsky. In the editorial foreword, Joseph E. Williams remarks about Suslov: "never before has a geographer set about his work with such a determined effort to understand all the physiogeographic forces acting in a given area."

S. P. Suslov's Physical Geography of Asiatic Russia might be regarded as a regionalized amplification of Berg's Natural Regions of U.S.S.R. (1937). It is a detailed delineation of the total landscape in the 15 regions east of the Urals and is well supplied with 50 maps and 168 illustrations. The coverage is comprehensive, for Suslov has analyzed the entire natural landscape, ranging from geology through meteorology, vegetation, and mining to zoology. This is more an encyclopedic survey than an objective evaluation, but it provides the best description in English of Western and Eastern Siberia, the Far East, and Central Asia.

The scope of the book is suggested by the subdivisions of the chapter on the mountain region of Central Asia. This chapter covers geologic history, mineral resources, glaciation, earthquakes, climate, relief-forming processes, hydrography, vegetation zones, and mountain landscapes. The discussion of permafrost covers 18 pages, but the limited attention given to mineral resources is shown by the fact that there is but one reference each to petroleum and iron. Coal is not listed, although it is mentioned under the Kuznets basin; there is no reference to water power.

The Soviet Union, by Georges Jorré, now appears in a second edition, translated from the French and revised by E. D. Laborde. The original volume, by the late Professor Jorré (University of Toulouse), was one of the best text-books when it was first published in 1950; the revision incorporates new statistical data with additions in the regional chapters.

Jorré's book is divided into four parts: the physical setting, the expansion of the Russian world, the economic system, and the main natural regions. The last part is subdivided along vegetation lines. The book is well balanced and interestingly written.

George B. Cressey Department of Geography,

Syracuse University

Tobacco and Man

Tobacco: Experimental and Clinical Studies. A comprehensive study of the world's literature. P. S. Larson, H. B. Haag, and H. Silvette. Williams and Wilkins, Baltimore, Md., 1961. xii + 932 pp. Illus. \$20.

Since the 16th century, when tobacco was introduced into Europe, its use has been a controversial matter. Robert Burton in his 17th-century Anatomy of Melancholy called the tune by saying "Tobacco, divine, rare . . . a sovereign remedy to all disease, a virtuous herb if it be well qualified, opportunely taken, and medicinally used, but as it is commonly abused by most men, 'tis a plague, a mischief. . . ." All the significant scientific information on this controversial subject has been well explored by the keen pharmacologists at the Medical College of Virginia. They have written this huge volume, comprising an analysis of over 6500 scientific references. It is well organized for ready reference to specific detail.

In these days when it is increasingly important for science to have comprehensive and critical reviews, this volume on tobacco offers an interesting example of what may be coming. Here in one place is all the pertinent information available on the effects of tobacco and its alkaloids on living material, and especially on human beings. There are over 100 pages, with three columns on a page, for the listing of references; full titles and full pagination are included.

The analysis goes directly into the

problem of the absorption and fate of alkaloids and other substances in tobacco as they are ingested, by inhalation or by other means, into the body. Then follows a consideration of the effects of tobacco and its alkaloids on the special senses, the nervous system, skeletal muscle, blood, the cardiovascular system, the respiratory system, the urinary tract, the gastrointestinal tract, the oral cavity, metabolism, the endocrine glands, and the reproductive organs. The pages are large and double-columned; the material discussed so far in this review covers nearly 400 pages.

The authors consider the local actions of tobacco, its detailed toxicity and hypersensitivity, tolerance, and habit. The immunology of tobacco is discussed, and there is a general survey of the effect of smoking tobacco on the human organism as a whole. There follows a consideration of tobacco and disease, not only from the standpoint of generalities, but also with reference to specific diseases. Consideration of lung cancer in relation to tobacco smoking is handled judiciously and fairly. There is even a chapter on medical uses of tobacco, and there are helpful appendixes on the biological and chemical methods for the estimation of nicotine, as well as notes on the pharmacology of certain derivatives of nicotine.

Certainly, for anyone desiring detailed information regarding the effects of tobacco, this volume must be a prime source. Its only failing is its lack of a historical survey covering some 400 years of accumulated writings on tobacco, most of which relate to various conflicting opinions on its merits. The initial introduction of tobacco into various parts of the world has always been as a medicine. Indeed tobacco remained in most of the pharmacopeias until the late 19th century. Nevertheless, by the 18th century, it was clear that tobacco was used more for amusement than for its medicinal virtues. Its potential dangers were well appreciated by the early 19th century.

Not the least of the interesting aspects of tobacco has been the extensive use of its chief alkaloid, nicotine, in the physiological analysis of the components of the autonomic nervous system. This was initiated by the famed English physiologist, John N. Langley (1852–1925). The authors discuss this fully and include references to 30 of Langley's contributions on this important matter.

For many years the authors of this

great compilation have been engaged in studying various aspects of the effects of smoking tobacco and of nicotine. This volume, which is so well organized and indexed, and which has such a comprehensive bibliography, will long remain a well appreciated record of their endeavor.

CHAUNCEY D. LEAKE
Ohio State University

Agronomists' Treatise

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Tropical and Subtropical Agriculture.
vol. 1 and vol. 2. J. J. Ochse, M. J.
Soule, Jr., M. J. Dijkman, and C.
Wehlburg. Macmillan, New York,
1961. liv + 1446 pp. Illus. \$35.

These boxed, cloth-bound volumes, are printed in easily read type on good quality paper. The authors, from the University of Miami and the University of Florida, have prepared a treatise that will be useful to college students, farmers, technicians, and crop administrators.

The first 368 pages contain general information on climate, physiography, soils, cultural practices, diseases and pests, and the economic possibilities relative to crops. The rest of the book treats important crops such as bananas, citrus and other fruit crops, spices, beverages (coffee, cacao, tea), rubber and cinchona, oil crops, fiber crops, sugar cane, rice, maize, sorghum, and tobacco. There are 285 illustrations.

It is not an easy task to review the two volumes, and I obtained the cooperation of experienced agronomists and horticulturists at the Agricultural Experiment Station and at the College of Agriculture of the University of Puerto Rico as well as a few others. Their comments follow:

"The authors strive to cover a vast field in two volumes. The depth and extension of the discussion has therefore been sacrificed to the scope. This is in part remedied by the appended bibliography, although this implies additional search on the part of the reader.

"Commendable features are the glossary, and the author-subject-common plant indexes. Too much space has been sacrificed in listing the names of plants in various languages and dialects at the beginning of the discussion of each crop. Such information could have been assembled in small print in

an appendix, and much needed space could have been saved for more useful information."

"Sea Island and Egyptian cotton are not the same. Sea Island Gossypium barbadense (L) Var. Maritima Watt., is perhaps the most valuable of all the different species.

"Egyptian cottons, as a class, are not so fine as Sea Island, but are superior to that of the American uplands for goods that require a smooth finish. In general, the data are accurate, but there is not enough information. As to the best fiber crop, the book is all right in a general way, but it lacks information on important fibers like flax and linen. The information about soybeans and sesame is accurate, although brief."

"Bixa orellana, commonly known as achiote or annatto, is an important plant in the tropics. Its seeds are used for coloring in food, cosmetics, and other items. In Puerto Rico alone, \$200,000 of achiote seeds are imported annually from the Dominican Republic, Mexico, and other producers. No mention of this plant is found in the book.

"The statement concerning the quality of fruits obtained from six different forms of trees of *Carica papaya* does not seem to be appropriate.

"The statements describing flower biology, breeding and selection, and so forth of *Coffee arabica* and other species should have been kept separate in order to make the views easier to understand."

"Tobacco. Flue-curing is not used in cigar-wrapper tobacco, but in bright cigarette tobacco. The method described in the rest of the paragraph, extending to page 1307 refers to flue-cured (bright) tobacco. Cigar-wrapper tobacco is wilt-fired (charcoal or Lpgas) during the first four or five days to remove excessive moisture and obtain light brown colors. Thereafter, the cure is completed by air-curing in more or less the same way used in dark air-curing.

"On page 1308, first line. Tobacco is usually fermented in a warehouse, not in a barn."

"The rest of the section on tobacco is very interesting; the topic is very well dealt with, in a short concise exposition."

"Rubber. This is a good chapter, fairly detailed but disappointing; it lacks modern information about physiology of rubber formation."

"Oil crops. Good, but the dwarf-tall hybrids developed in Ceylon are neg-

lected. Also, in view of the growing economic importance of coconut diseases, quite a bit more information on this could have been included."

"Sugar cane. A good chapter, but tensiometers and gypsum or nylon blocks are used in the commercial irrigated sugar fields in Hawaii for water control of the sugar cane plant."

JUAN A. BONNET Agricultural Experiment Station, University of Puerto Rico

Showmanship

Physics for the Inquiring Mind. The methods, nature, and philosophy of physical science. Eric M. Rogers. Princeton University Press, Princeton, N.J., 1960. 778 pp. Illus. \$8.50.

Eric Rogers's course in physics for nonscience students at Princeton University has been famous for many years: it is probably the best known and most deservedly popular course of its kind in the country. Now he has put it down in a very handsome book, for all to see and possibly attempt to emulate.

In general terms, the physics is sound, the plan of organization novel but well thought out, the presentation ingeniously varied, often toward the end that the student can acquire ideas with a real sense of participation in the development. There is much use of familiar analogies to sports and other activities. The illustrations reflect some of the author's great showmanship with demonstrations. There are literary allusions and occasionally historical references to "tie in" the physics. The style is breezy and informal, so that the reader is carried along through what would otherwise seem a frightening amount of print, although some may not feel comfortable with such conceits as "the neutrino . . . he," and the like.

The ingenuity which produces so many useful parallels and analogies is always in danger of attributing to the discoverer of a scientific idea the motivation desired for pedagogical purposes. For example, there is no evidence, so far as one can see from the original paper, that Maxwell introduced the displacement current for reasons of mathematical symmetry; indeed, his justification, when he got around to giving one, involved the familiar condenser paradox with the circuital form of Am-

pere's law. But the present author falls into this trap no oftener than other textbook writers.

Undoubtedly there exists a large body of college students whom this book could reach by virtue of its expert showmanship, not by its essential scientific soundness. It remains to be seen whether a book which reflects so strongly the personal style of its creator can be used to full advantage by a wide range of other physics teachers.

MELBA PHILLIPS

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Verbalized Values

A Grammar of Human Values. Otto von Mering. University of Pittsburgh Press, Pittsburgh, Pa., 1961. xx + 288 pp. \$4.50.

Probably as a reaction to the charge that the comparative data of their discipline have fostered cultural relativism and thus have contributed to unsettling the foundations of modern Western morality, anthropologists have lately been addressing themselves to a search for universal values or, at least, for universal value categories. In this book Otto von Mering, as part of a larger study sponsored by Harvard's Laboratory of Social Relations, reports on a comparative field study of the value systems of two small communities in New Mexico, one composed of Mormons and the other of homesteaders from Texas and Oklahoma who settled in their present location during the dustbowl days of the 1930's. Von Mering tried to elicit statements which could be analyzed for elements containing value judgments by bringing together small groups of these people and inducing them to talk about their neighbors, the Navaho Indians, The discussions were recorded and carefully studied. These data were supplemented by questionnaire responses. obtained from members of the discussion groups, which probed the amount and nature of each one's contact with the Navaho.

On the basis of this material von Mering devised four major headings, divided into 34 categories, under which can be placed statements he considers to have significance for value theory. This is his "grammar of human values." By the differential clustering of value statements in the categories, he attempts to show that the two communities do present contrasting value profiles.

One interesting facet of this study is that it is an attempt to extend the small group technique to a new field of research. Also, on the positive side, one must admire von Mering's boldness of plan. He believes his "grammar" may be a framework which has universal application and may be one in terms of which different organizations of values can be tested. Hence, he invites comparative work.

The limitations of the study are also fairly obvious. It is plain that the meaningful involvement of von Mering's respondents with the Navaho is slight. The Navaho could all sink at once into a deep hole and this would make very little difference, emotionally or practically, to the members of these groups, Even those who are inclined to be charitable in their estimates of the Navaho are abysmally uninformed about them. Can sound value theory or value categories of a group stem from what is unimportant and tangential to that group? Moreover, this is all discussion and assertion. These folk tell us what they think ought to be done about Navaho education, sanitation, ceremonies, and the like. There is nothing to suggest that they have taken steps to implement their opinions or that they have the remotest intention of doing so in the future. Verbalization is one kind of activity, but surely other types of performance must be considered in assessing the value system of a group.

Many will feel, too, that the canvas von Mering employs is too narrow for what he seeks to portray. His comparison of the value systems of the two groups in question is based exclusively on their reactions to the Navaho. No doubt they reveal a good deal about themselves in their comments about the Indians, but we need some assurance that the groups' thought and action patterns concerning work, religion, family, and government would yield parallel results. One can sum matters up by saying that this book is timely, novel, and ingenious but not entirely convincing.

MORRIS E. OPLER

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Political Power Study

Small Groups and Political Behavior. A study of leadership. Sidney Verba. Princeton University Press, Princeton, N.J., 1961. xii + 273 pp. \$6.

Community Political Systems. vol. 1, International Yearbook of Political Behavior Research. Morris Janowitz, Ed. Free Press, Glencoe, Ill., 1961. 259 pp. \$7.50.

Political behavior studies seek to unify theory and research in political science, to demand carefully designed empirical methods, and to utilize all the tools and findings of the other social sciences. Sidney Verba's book explores the relevance for political science of certain theories developed by sociologists and social psychologists who have been studying the behavior of small face-to-face groups. Morris Janowitz edited a group of symposium papers concerned with empirical studies of different aspects of urban politics, largely in the United States.

Verba claims that from the experimental studies of small group, face-toface behavior some usable theories may be obtained for political science. He does not present a new theory of politics but brings together certain bits which, he hopes, may later be fitted into a larger picture. Although the book deals with many so-called experimental studies, it cannot present in the space available an evaluation of the methods used. The reader who has not gone through the extensive literature himself has to accept the author's claim that the studies reported used sound methods.

Verba does an excellent job in showing that, in the political process, important decisions are made by small face-to-face groups. Courts, cabinet meetings, administrative tribunals, and legislative committees are discussed as examples of important decision-making bodies. The author finds it more difficult to relate experimental studies to on-going social processes. Since most of the experimental small groups were made up of American students, campers, or club women; the findings apply largely to American conditions. It would be highly desirable to test them in other cultures. Verba attempts to apply the methods of measuring and identifying leadership in small group studies to the study of political leadership, and he analyzes the relation between affective and instrumental leadership, the relation between norms of the group and social change, and the effects of participation in decisions on the nature of the decision and on its degree of acceptability. His book is a distinct contribution to the study of

political power.

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Janowitz brings together five case studies, from the United States, on different aspects and approaches to urban community political systems and one study of an electoral contest held in a Norwegian province. The American urban communities studied include a small trading center or town, a satellite city, a suburban community, a larger industrial city, and a giant metropolis. The methods used in these studies include historical analysis, survey techniques, statistical analysis, the ecological approach, and case study. Since these studies use different hypotheses, different methods, and different definitions, it is hard to compare them. Among the significant findings are the decline of the influence of large businessmen in community affairs, the survival of the old patronage system in an industrial satellite city, and the lack of priorities among business leaders as to their self-interests.

HAROLD F. GOSNELL Special Operations Research Office, American University, Washington, D.C.

New Books

Biological and Medical Sciences

Biological Approaches to Cancer Chemotherapy. R. J. C. Harris, Ed. Academic New York, 1961. 442 pp. Illus. \$14. Papers presented at a symposium held at Louvain, Belgium, June 1960. under the auspices of UNESCO and the World Health Organization.

Biological Education in American Secondary Schools, 1890-1960. Paul DeHart Hurd. American Inst. of Biological Sciences, Washington, D.C., 1961. 272 pp.

\$4.75.

Bone. An introduction to the physiology of skeletal tissue. Franklin C. McLean and Marshall R. Urist. Univ. of Chicago Press, Chicago, Ill., ed. 2, 1961. 278 pp. Illus. \$6.

Chemistry of Drug Metabolism. William H. Fishman. Thomas, Springfield, Ill., 1961. 252 pp. Illus. \$10.50.
Electrical Activity of Single Cells. Ya-

suji Katsuki, Ed. Shoin, Tokyo, Japan, 1960. 320 pp. Illus.

Elements of Biology. Paul B. Weisz. McGraw-Hill, New York, 1961. 505 pp.

The Enzymes. vol. 5. Paul D. Boyer,

Henry Lardy, and Karl Myrbäck, Eds. Academic Press, New York, ed. 2, 1961. 664 pp. Illus. \$20.

Genetic Research. A survey of methods and main results. Arne Muntzing. Lts. Forlag, Stockholm, Sweden, 1961. 345

Integrated Principles of Zoology. Cleveland P. Hickman. Mosby, St. Louis, Mo.,

ed. 2, 1961. 972 pp. Illus. \$7.75.

Listeriosis. H. P. R. Seeliger. Hafner,
New York, 1961. 320 pp. Illus. \$14.25.

Parasitology. The biology of animal parasites. Elmer R. Noble and Glenn A. Noble. Lea and Febiger, Philadelphia,

Pa., 1961. 767 pp. Illus. \$11.

Protein Biosynthesis. R. J. C. Harris, Ed. Academic Press, New York, 1961. 421 pp. Illus. \$14. Papers presented at a symposium held at Wassenaar, Netherlands, in August and September 1960 under the auspices of UNESCO and the Council for International Organizations of Medical Sciences.

The Yorkshire Jurassic Flora. pt. 1, Thallophyta-Pteridophyta. Thomas Maxwell Harris. British Museum (Natural History), London, 1961. 221 pp. Illus.

Economics and the Social Sciences

The Annual Survey of Psychoanalysis. vol. 6, 1955. John Frosch and Nathaniel Ross, Eds. International Univers Press, New York, 1961. 623 pp. \$12. International Universities

Classics in Psychology. Thorne Shipley, Ed. Philosophical Library, New York,

1961. 1362 pp. \$20.

Language and the Discovery of Reality. A developmental psychology of cognition. Joseph Church. Random House, New York, 1961. 263 pp. \$4.

Motivation and Emotion. A survey of the determinants of human and animal activity. Paul Thomas Young. Wiley, New

York, 1961. 672 pp. \$10.75.

Prehistoric Agriculture at Point of Pines, Arizona. Richard B. Woodbury. Univ. of Utah Press, Salt Lake City, 1961. 62 pp. Illus. Paper, \$1.50. Memoirs of the Society for American Archaeology, No. 17; Contributions to Point of Pines Archaeology, No. 16.

Recognizing the Depressed Patient. With essentials of management and treatment. Frank J. Ayd, Jr. Grune and Strat-

ton, New York, 1961. 143 pp. Science in General Education. Robert Ray Haun, Ed. Brown, Dubuque, Iowa,

1960. 301 pp. Illus. \$4.50.

The Structure of Science. Problems in the logic of scientific explanation. Ernst Nagel. Harcourt, Brace and World, New York, 1960. 631 pp. \$7.50.

Studies in Item Analysis and Prediction. Herbert Solomon, Ed. Stanford Univ. Press, Stanford, Calif., 1961. 322 pp. Illus. \$8.75.

Stuttering and What You Can Do about It: Wendell Johnson. Univ. of Min-

Palter, Ed. Noonday Press, New York,

1961. 284 pp.; 218 pp. Illus. \$5 each;

\$9 per set.

Völkerkunde. Burghard Freudenfeld. Ed. Beck, Munich, Germany, 1960. 165 pp. DM. 8.80.

Year Book, 1959. 1 July 1959 to 30 June 1960. Carnegie Institution of Washington, Washington, D.C., 1960. 526 pp. Illus. + plates.

General

The Association of American Physicians. Its first 75 years. James Howard Means, McGraw-Hill, New York, 1961. 323 pp. \$10.

Education and Income. Inequalities of opportunity in our public schools. Patricia Cayo Sexton. Viking Press, New York,

1961. 319 pp. \$6.

The Family. A focal point in health education. Iago Galdston, Ed. International Universities Press, New York, 1961. 216 pp. \$3. Based on the Eastern States Health Education Conference (1956).

Medicine. A lifelong study. Proceedings of the second world conference on medical education, Chicago, 1959. Hugh Clegg, Ed. World Medical Assoc. and British Medical Journal, London, 1961. 836 pp. \$17.

The Pyramids. Ahmed Fakhry. Univ. of Chicago Press, Chicago, Ill., 1961. 270

pp. Illus. \$5.95.

Mathematics, Physical Sciences, and Engineering

Geochronology of Rock Systems. Annals, vol. 91, art. 2, pp. 159-594. J. Laurence Kulp, Ed. New York Acad. of Sciences, New York, 1961.

An Index of Published Infra-Red Spectra. vols. 1 and 2. Edited by the Technical Information and Library Service, Ministry of Aviation. Her Majesty's Stationery Office, London, 1960 (order from British Information Services, New York). 815 pp. Set, \$18.40.

An Introduction to Co-ordination Chemistry. D. P. Graddon. Pergamon, New York, 1961. 118 pp. Illus. \$4.

Laboratory and Workshop Notes, 1956-58. Compiled and edited by Ruth Lang for the Institute of Physics. Arnold, London; St. Martin's Press, New York, 1961. 230 pp. Illus. \$9.50. Selections reprinted from the Journal of Scientific Instru-

Microanalysis by the Ring Oven Technique. Herbert Weisz. Pergamon, New

York, 1961. 112 pp. \$5.

Progress in Ceramic Science. vol. 1. J. E. Burke, Ed. Pergamon, New York,

1961. 239 pp. Illus. \$10. Review of Textile Progress. vol. 11, 1959. Interscience, New York; Butterworths, London, 1960. 458 pp. Illus. \$10.

Shielding Materials for Nuclear Reactors. A. N. Komarovskii. Translated from the Russian by V. M. Newton. H. W. Curtis, Ed. Pergamon, New York, 1961. 151 pp. \$9.50.

Silicones. S. Fordham, Ed. Philosophical Library, New York, 1961. 263 pp.

Illus. \$10.

nesota Press, Minneapolis, 1961. 220 pp. Toward Modern Science. vol. 1, Studies in Ancient and Medieval Science; vol. 2, Studies in Renaissance Science. Robert M.

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Reports

Isolation and Identification of a Neuroactive Factor from Lathyrus latifolius

Abstract. A neuroactive principle of Lathyrus latifolius has been isolated in crystalline form as a monohydrochloride and has been identified as L-α,γ-diamino-butyric acid. This amino acid has also been found in very high concentration in the toxic seed of Lathyrus sylvestris Wagneri. A structural relationship between this factor, the lathyrus factor from Lathyrus odoratus, and β-cyano-L-alanine, a new, synthetic neuroactive amino acid nitrile, is pointed out, and a possible biosynthetic pathway relating these is indicated.

Recently the synthesis of β-cyano-Lalanine, the amino acid nitrile derived from L-asparagine through dehydration of its β -carboxamide, was reported, and some of its physical and chemical properties were described (1). It may be noted that B-cyano-L-alanine represents structurally the parent amino acid which by biological decarboxylation could form β-aminopropionitrile, the active moiety (2) of the lathrogen isolated from Lathyrus odoratus (flowering sweet pea) and characterized as β -N-(γ -L-glutamyl) aminopropionitrile (3). We therefore became interested in examining the biological properties of the amino acid nitrile. It was found that \(\beta\)-cyano-L-alanine at a 1-percent level in a standard laboratory diet produces in the young male white rat within 3 to 5 days severe nervous symptoms—that is, hyperirritability, tremors, and convulsions, followed by death (4). Lewis and co-workers, in their studies on experimental lathyrism, have described these same symptoms in the rat after ingestion of the lathyrus species L. latifolius (perennial sweet pea) and L. sylvestris Wagneri (flat pea) (5). From their work, the presence of a second lathyrus principle, a powerful neurotoxin, was suggested (6), and efforts to isolate the principle from L. sylvestris Wagneri were described (7). The neurological effects of these plants and of β-cyano-L-alanine are of particular interest in connection with the occurrence of spontaneous clinical neurolathyrism, a condition which has been known for centuries and which has been associated in many instances with the consumption of excessive amounts of lathyrus meal in times of food scarcity (8).

A number of synthetic aminonitriles structurally related to \(\beta\)-aminopropionitrile have been administered before to experimental animals, and several of these were found to possess the osteolathrogenic activity of \(\beta\)-aminopropionitrile (2). β-Cyano-L-alanine, however, is so far unique in reproducing the neurological symptoms associated with some of the plants. We have therefore examined L. latifolius and L. sylvestris Wagneri for the presence of Bcyano-L-alanine as the possible natural neurolathrogen in those seeds (9). In this report (10) we describe the isolation of the chief neurotoxic principle of L. latifolius, and its identification as $L-\alpha,\gamma$ -diaminobutyric acid. The same substance is also present in L. sylvestris Waoneri.

In the course of the purification and isolation of the latifolius factor, the distribution of activity was followed by a bioassay which consisted of the administration of aqueous extracts by stomach tube to weanling male Sherman rats (11). Within 48 hr weakness in the hind legs was apparent, and

tremors in the upper extremities suddenly started, followed after several hours by convulsions and death. Subcutaneous administration was less satisfactory since neurological symptoms were not as obvious although toxicity developed. Hexane-extracted ground L. latifolius seed (12), 370 g, was extracted three times with a total of 5.4 liters of 30 percent ethanol (13). The extract yielded 57 g of an active brown semisolid; toxic dose 2.3 g. This was treated in 10 percent aqueous solution with 5 g of activated charcoal, and ethanol was added to 75 percent. The resulting semisolid, 29 g, toxic dose 1.0 g, was dissolved in water and was subjected in 2.7-g aliquots to preparative electrophoresis in pyridine acetate, pH 5.58, on Solka-floc (Brown Company, New Hampshire) for 36 hr at +5°C at 8 volt/cm. Assay of the block in segments showed activity only in one basic region 10 to 17 cm from the origin. The combined active eluate of three electrophoretic runs after evaporation yielded 0.96 g; toxic dose 120 mg. This material, 0.8 g, was again subjected to electrophoresis, over a longer distance. Active material was eluted from fraction 1 at 23.8 to 27 cm, 179 mg, and from fraction 2 at 19.5 to 23.7 cm, 157 mg. Each fraction was lyophilized from 30 ml of 0.1N hydrochloric acid. The residues were dissolved in water and the solutions were adjusted to pH 5. On addition of ethanol, fraction 1 crystallized as prisms; wt. 125 mg; mp 229.5-230° dec.; $(a)^{22}D + 23.3^{\circ}$ (c, 2.1; 5N HCl); anal. C, 31.2; H, 7.18; N, 17.7; Cl, 22.8; picrate mp, 181-181.5°; toxic dose 68 mg. Fraction 2 vielded 104 mg. mp 228.5° dec.; toxic dose 68 mg. The active crystalline material represents a recovery of approximately 59 percent of the activity and 1.7 percent of the weight in the initial aqueous ethanol extracts, and approximately 0.25 percent of the weight of the seed.

In the electrophoretic isolation, activity was closely associated with basic, ninhydrin-positive material. The latter was identified as a,y-diaminobutyric acid by comparison with an authentic sample in the following systems: electrophoresis in pyridine acetate, pH 5.7; electrophoresis in barbital buffer, pH 8.6; chromatography on Dowex-50 with the Beckman-Spinco automatic amino acid analyzer (14) with the 50-cm column and 0.38 N sodium citrate buffer, pH 4.26, at 30°C, and

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

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ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references

and notes.

Limit illustrative material to one 2-column figure (that is, a figure whose width equals two columns of text) or to one 2-column table or to two I-column illustrations, which may consist of two figures or two tables or one of each. For further details see "Suggestions to contributors" [Science 125, 16 (1957)].



Fig. 1. Hypothetical biosynthetic pathway in Lathyrus. (a) L. odoratus; (b) L. latifolius and L. sylvestris Wagneri.

also at 50°C. The latter system at 50°C, like electrophoresis at pH 8.6, allows differentiation of a,y-diaminobutyric acid (191 ml) from ornithine (182 ml). That the crystalline latifolius factor was indeed L-α, γ-diaminobutyric acid monochloride was confirmed by comparison of the isolated active material with an authentic sample (15, 16) with the following properties: anal. (calc.) C, 31.1; H, 7.17; N, 18.1; Cl, 22.9; mp 230-230.5° dec., reported 225° (17), picrate mp 180.5-181.5°, reported 180° (18); (a) D +23.9°, (c 2.1, 5N HCl), reported (a) 25D $+ 24.2^{\circ}$ (c 2, 5N HCl) (16). There were no differences in infrared spectra (KBr disk). Finally, synthetic L-a, ydiaminobutyric acid monohydrochloride led at a level of 68 mg within 2 days to weakness in the hind legs, tremors, convulsive behavior, and

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Quantitative determination (14) of a,y-diaminobutyric acid in 30 percent ethanol extracts of several samples indicated concentrations in L. latifolius seed of 0.51 to 0.67 percent, expressed as the monohydrochloride. Similar analysis of L. sylvetris Wagneri (19) showed a 1.4-percent level. High concentrations of arginine (0.3 to 0.4 percent) were also present in both seeds. The concentration of L-a, y-diaminobutyric acid in L. latifolius, together with the knowledge of the toxic level of this amino acid in the rat, allows one to account fully for the toxicity of the seed (13). Since, in addition, activity was found only in fractions containing the diaminoacid, it is evident that L-α, γ-diaminobutyric acid is the chief neurotoxic principle in L. latifolius. The extremely high level of free a,y-diaminobutyric acid found in the seed of L. sylvestris Wagneri now explains why ingestion of as little as several grams of this seed has proved so highly toxic to the rat (5-7), and this amino acid probably also accounts for the toxicity to some classes of livestock encountered during trials of the immature flat pea plant as a forage (20). It may be noted that the relative toxicities of the two seeds are roughly in accord with their concentrations of a,ydiaminobutyric acid, L. sylvestris Wagneri being reportedly three to four times more toxic to the rat than L. latifolius

It is of interest that although synthetic L-a, y-diaminobutyric acid has long been available, its neurotoxic action, although briefly mentioned in the literature (21), has remained virtually unnoticed in neurochemistry. Although present in peptide linkage in the naturally occurring polymyxin, circulin and colistin families of antibiotics, a,y-diaminobutyric acid has been encountered before this study in plants in only trace amounts (22), and this appears to be the first report in which free L-a, y-diaminobutyric acid has been recognized as a naturally occurring neurotoxin. Noteworthy in view of the pharmacological activity of a,y-diaminobutyric acid is its recent identification in mammalian liver (23) and in the road snail (24). It will be of interest to ascertain its presence in common foodstuffs as well as in those lathyrus species implicated in clinical lathyrism (25). Whether it is a natural factor of significance to man, perhaps, in connection with the action of the structurally related y-aminobutyric acid in cerebral metabolism, remains to be

It is interesting that in attempting to determine the presence of \(\beta\)-cyano-Lalanine as the active factor in L. latifolius we have instead established the active factor to be its reduction product, L-a, y-diaminobutyric acid. Although our evidence for a biological relationship between these two substances is only circumstantial, chemical analogy (26) could suggest the metabolic relationship illustrated in Fig. 1. B-Cyano-L-alanine, derived possibly from asparagine by dehydration in

analogy with its laboratory preparation, could serve as the biological intermediate which in L. odoratus is decarboxylated to \(\beta\)-aminopropionitrile, whereas in L. latifolius and in L. sylvestris Wagneri it is reduced to anydiaminobutyric acid. These reactions involving the formation and reduction of a nitrile would presumably be catalyzed by enzymes of types—that is, "amide dehydrase" and "nitrile reductase"-which are as yet unknown.

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References and Notes

- 1. C. Ressler and H. Ratzkin, J. Org. Chem.,
- in press.

 2. W. Dasler, Proc. Soc. Exptl. Biol. Med.

 38, 196 (1955); T. E. Bachhuber, J. J. Lalich,
 D. M. Angevine, E. D. Shilling, F. M.

 Strong, ibid. 89, 294 (1955); S. Wawzonek,
 I. V. Ponseti, R. S. Shepard, L. G. Wiedenmann, Science 121, 63 (1955).

 3. E. D. Shilling and F. M. Strong, J. Am.

 Chem. Soc. 77, 2843 (1955).

 4. C. Ressler, manuscript in preparation.

 5. H. B. Lewis and A. R. Schulert, Proc. Soc.

 Exptl. Biol. Med. 71, 440 (1949).

 6. H. B. Lewis, R. S. Fajans, M. B. Esterer,

 C.-W. Shen, M. Oliphant, J. Nutrition 36,

 537 (1948).

- 537 (1948).
- 7. A. R. Schulert and H. B. Lewis, Proc. Soc.
- A. R. Schulert and H. B. Lewis, Proc. Soc. Exptl. Biol. Med. 81, 86 (1952).
 For reviews of the subject of experimental and clinical lathyrism, see H. Selye, Rev. can. biol. 16, 1 (1957); A. F. Gardner, Am. J. Clin. Nutrition 7, 213 (1959).
 We should like to thank Quentin Jones, U.S. Department of Agriculture, and Richard M. Klein, New York Botanical Gardens, for assistance in locating the seeds and Gilbert N. Schnirman for capable assistance with the preparative experiments.
 This work was supported by a grant from
- 10. This work was supported by a grant from the Muscular Dystrophy Associations of America, Inc. One of us (P.A.R.) was the recipient of a MDAA student summer scholarship (1960).

 11. We are indebted to Maurice B. Feinstein for suspecting this procedure.
- for suggesting this procedure.

 12. The seed was purchased from Herbst Brothers Seedsmen, Inc., New York, N.Y.

 13. It had been shown previously in experiments
- with mice that the toxic principle is re-moved with 30 percent ethanol (5). Estimawith fince that the toole principle is removed with 30 percent ethanol (5). Estimation here of the toxicity of the seed has
 been based on that of the ethanol extracts. This toxicity, 15 g, was somewhat
 greater and much less variable than that
 which resulted when the powdered seed was
 administered in a 50 percent diet mixed with
 laboratory chow, average 22.5 g, perhaps
 due to the more gradual assimilation through
 the latter route. Toxic dose in the stomach
 tube assay is weight per 100 g of rat, which
 consistently caused death and was usually
 not lethal at a 20 percent lower level.

 14. D. H. Spackman, W. H. Stein, S. Moore,
 Anal. Chem. 30, 1190 (1958).

 15. The sample was prepared by the methods
 of Fu et al. (16) from the dihydrochloride
 purchased from Mann Research Laboratories,
 Inc.

- S. J. Fu, K. R. Rao, S. M. Birnbaum, J. P. Greenstein, J. Biol. Chem. 199, 207 (1952).
 S. Wilkinson, J. Chem. Soc. 1951, 104 (1951).
- 18. D. W. Adamson, ibid. 1939, 1564 (1939).
- Lathyrus sylvestris Wagneri was obtained through the kindness of H. M. Austenson, Western Washington Experiment Station,

Puyallup, Wash., to whom we express ap-

preciation.

20. M. S. Grunder and N. S. Dickson, "Circular No. 104 on Flat pea" (Western Washington Experiment Station, Puyallup, 1948).

T. R. Riggs, B. A. Coyne, H. N. Christensen, J. Biol. Chem. 209, 395 (1954).
 F. C. Steward, R. M. Zacharius, J. K. Pollard, Ann. Acad. Sci. Fennicae Ser. A 11 60,

ard, Ann. Acad. Sci. Fennicae Ser. A II 60, 321 (1955); L. Fowden and M. Bryant, Biochem. J. 70, 626 (1958).
 G. Fischer and H. Naarmann, cited by D. Ackermann and H. G. Menssen, Z. physiol. Chem. Hoppe-Seyler's 318, 212 (1960).
 D. Ackermann and H. G. Menssen, Z. physiol. Chem. Hoppe-Seyler's 318, 212 (1960).

Chem. Hoppe-Seyler's 318. (1960).

25. There appears to be some uncertainty concerning the identity of the species involved

 Chemical analogy exists, for example in a re-action encountered in the synthesis of an asparagine-containing pentapeptide, whereby the asparagine moiety was converted in part by a peptide-coupling agent, that is, dehy-drating agent, followed by reduction, to a residue of a,γ -diaminobutyric acid [C. Ressler, J. Am. Chem. Soc. 78, 5956 (1956)]. A β-cyanoalanine derivative was shown to be the likely intermediate in this conversion (1).

11 March 1961

Sulfate-Reducing Bacteria and **Pyritic Sediments in Antarctica**

Abstract. Black lacustrine and marine sediments occur in the McMurdo Sound region of Antarctica. The black color is due to the presence of iron sulfide, precipitated by sulfate-reducing bacteria (Desulfovibrio) in the presence of decaying organic matter of algal origin. Viability of sulfate-reducing bacteria in the sediments was demonstrated in the laboratory by culturing in anaerobic liquid media. It is probable that sulfate-reducing bacteria are widely distributed in Antarctica.

The significance of sulfate-reducing bacteria (Desulfovibrio) as biological and geologic agents has been widely recognized since the classic work of Beijerinck (1) and van Delden (2). Numerous investigators have confirmed the significance of these organisms in the geochemical cycle of sulfur, although their quantitative role is not clearly established in either recent or ancient sediments. The ubiquitous presence of sulfate reducers in a wide range of sedimentary environments has been demonstrated in studies of bottom muds from fresh-water, marine, and saline basins. Their temperature tolerance under natural conditions, however, has not been delimited. The presence of sulfate-reducing bacteria as active agents in sedimentary processes under the extreme conditions of the antarctic environment is therefore of interest both with respect to their ecological tolerance and geographic distribution.

Kettle holes are common on the south side of the Wright Dry Valley in the McMurdo Sound region of Antarctica.

These holes are located in an area extending westward from the western terminus of the Lower Wright Glacier for about 2 mi (lat. 77°30'S, long. 162°30'E). Small ponds occur in some of the kettle holes, although most of them are dry.

A small saline pond, approximately 25 ft long, 10 ft wide, and 1 ft deep, occurs in one of the kettle holes. The water is impotable and highly saline, as shown in the analysis presented in Table 1. From the values in the table, it can be seen that the salinity of the pond water is approximately four times that of sea water. The principal dissolved salt is sodium chloride. Magnesium chloride, calcium sulfate, magnesium sulfate, and calcium carbonate are also present.

The upper surface of the sediments at the bottom of the pond is light ocherous brown. Immediately below the surface and extending down, however, the sediment is black. Upon drying under oxidizing conditions, the black sediments become gray. Upon addition of dilute HCl to the black sediment, hydrogen sulfide gas is emitted. The black color is due to the presence of iron sulfide, probably of the type described as hydrotroilite (FeS-nH2O), an amorphous, hydrous monosulfide of iron (3). The iron sulfide is precipitated by sulfate reduction induced by Desulfovibrio in the bottom muds. An energy source for the sulfatereducing bacteria is readily available from decaying filamentous algae, diatoms, and other microplankton that occur in the pond waters. The existence of a rather complex biocenose, involving the sulfur cycle, under the ecological conditions currently prevailing in the pond is remarkable. In addition to the markedly high salinity of the water, the temperature regime, under which the sediments and their organic fraction are accumulating, is featured by changes from perhaps -60°F in winter to +40°F in summer (4).

The presence of living cells of Desulfovibrio in the pond sediments under consideration has been demonstrated in the laboratory by culturing in anaerobic sterile liquid media containing lactate as a carbon source. Replicate media were prepared by the use of both tap water and slightly saline water (NaCl). Better growth occurred in the saline medium. Cultures held at room temperature showed a more rapid rate of sulfate reduction than those held at 5°C. The precipitation of iron sulfide,

Table 1. Analysis of a sample of water from a small saline pond in the McMurdo Sound region of Antarctica (pH 7.8). (The analysis was made by the Water Analysis Laboratory of Metcalf and Eddy, Boston, Mass.)

Substance	Amount (mg/lit.)
Calcium as Ca	1,130.
Magnesium as Mg	4,890.
Sodium as Na	33,200.
Sulfates as SO ₄	16,150.
Chlorides as Cl	58,000.
Bicarbonates as CO ₃	330.
Sulfides as S	< 0.1
Dissolved solids	132,620.

as visually indicated, was used to determine viability of the cultures, and the rate of precipitation was used to indicate the relative rates of sulfate reduction. The laboratory cultures were prepared from samples collected by one of us (R.L.N.) on 9 January 1961. The samples were held under moist, relatively anoxic conditions until 1 February 1961, the time of inoculation of the media, a period of approximately 3 wk.

Pyritic sediments, similar to those described here, occur in other kettle holes in the Wright Dry Valley, on the marine beach on the south side of New Harbor, McMurdo Sound (lat. 77°35'S, long. 163°29'E), in the deposits of Green Lake, Cape Royds, Ross Island (lat. 77°32'S, long. 166°15'E) (5), and in a small pond in the elevated marine beaches at Marble Point, McMurdo Sound (lat. 77°26'S, long. 163°46'E). It is probable that further field and laboratory study will demonstrate that sulfate-reducing bacteria and pyritic sediments are widely distributed in Antarctica. It would be of interest to determine the optimum temperature for growth in strains of Desulfovibrio occurring in nature under these extreme environmental conditions (6).

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References and Notes

- 1. M. W. Beijerinck, Zentr. Bakteriol. Parasitenk.
- Abt. II 1, 1, 49, 104 (1895).

 A. van Deiden, ibid., 11, 81, 113 (1904).

 W. H. Twenhofel, Principles of Sedimentation (McGraw-Hill, New York, ed. 2, 1950), p.
- (McGraw-Hill, New York, ed. 2, 1950), p.
 431.
 4. G. C. Simpson, British Antarctic Expedition
 1910-1913, vol. 3, "Meteorology" (Harrison
 and Sons, London, 1923), p. 40.
 5. T. W. E. David and R. E. Priestley, British
 Antarctic Expedition 1907-1909, Reports on
 the Scientific Investigations, vol. 1, "Geology"
 (Heinemann, London, 1914), pp. 149, 156.
 6. The field studies by one of us (R.L.N.) were
 made possible by the assistance of the National Science Foundation.

27 February 1961

Foam Fractionation with Reflux

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Abstract. A surface-active aqueous solution was foamed up a glass column, removed, collapsed, and returned as downcoming liquid to drain countercurrently against the rising foam. This deliberate refluxing action greatly increased the degree of separation of the surfactant over that obtainable without reflux. The effects of altering the gas rate and the solute concentration were also studied.

There are several common methods for physically concentrating or separating the components of a liquid solution. Examples are distillation and extraction. These methods depend on differences in concentration between different physical phases in contact with one another. Where such differences are small, countercurrently flowing reflux can be used to cascade them and thus increase the over-all separation obtain-

Now, a less usual method, namely foam fractionation, has been proposed and even used on occasion (1). In this method the separation depends on surface activity. One (or more) components of the solution are absorbed at any surface formed, so that bubbling off foam from the solution produces a partial separation of components. Unfortunately, the degree of such separation is usually very modest (2). Accordingly, an experimental study (3) was begun to examine the feasibility of using reflux to increase analogously the over-all separation obtainable with foam fractionation. Some results of this study are reported here.

The apparatus employed is shown in

MOTOR FOAM ENTIRE SPLITTER FRACTIONATION ALONG SAMPLER SAMPLERS POAM

Fig. 1. Foam fractionation apparatus (not to scale).

Six

the abbreviated schematic diagram (Fig. 1). The foam fractionation column was of glass with a diameter of 1 in. and a height of 6 ft. The mixture used was a dilute aqueous solution of the commercial surfactant Aresket-300 (monobutyl diphenyl sodium monosulfonate). The solution was charged to a 2-liter flask at the bottom of the column. Nitrogen, which had first been thoroughly moistened in a preliminary packed absorption column in order to eliminate any spurious evaporative effects, was bubbled through the charge at a controlled and measured rate. Foam rose through the column, out the top, and into a centrifugal foam breaker consisting of a spinning wire basket in a very large funnel. Collapsed foam flowed by gravity from the funnel stem, and a portion was returned to the column some distance down from the top. (Pressure in the column prevented introduction directly at the top.) The remainder of the collapsed foam was drawn off as concentrated "product." However, in order to achieve steady state and avoid the necessity for continually replenishing the charge, the product was simply returned by gravity to the flask at the

Samples for analysis were withdrawn repeatedly from the reflux line in order to check the approach to steady state. Some runs were continued for as long as 48 hr. Just before shutdown, samples were drawn from the top, bottom, reflux line, and locations along the column length generally at 5-in. intervals.

Much of the work was carried out in a factorial experiment. The effects of reflux ratio, solute concentration, gas rate, and column level were studied. At high reflux ratios the concentration increased considerably up the column. In fact, for total reflux an overhead concentration in excess of 10 times the charge concentration was obtained, as shown in Fig. 2. However, without external reflux the increase in concentration was far less. In other words, the downcoming reflux greatly enriched the rising foam so that the column acted as a rectifier (enricher). Thus the utilization of reflux can greatly increase the ability of a foam fractionation device to concentrate a constituent of a solu-

Decreasing the gas rate increased the degree of separation. This is attributed in part to decreased channeling (which was readily visible) and longer residence time at the lower rate, which make for better over-all contact between rising

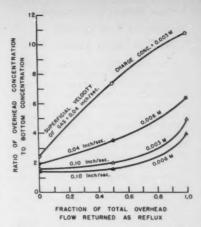


Fig. 2. Performance of a foam fractionation column, showing the beneficial effect of reflux. The effects of different solute concentrations in the charge and different gas rates are also shown.

bubbles and downcoming liquid. A larger residence time also permits somewhat more foam drainage and collapse in the column (which were also visible). thus promoting some degree of selfreflux. Also in line with these several reasons, in some auxiliary work an increase in separation resulted from an increase in column diameter,

The degree of separation increased somewhat with a decrease in charge concentration. This follows from the relatively stronger tendency toward surface adsorption that generally exists at lower concentrations. However, it is worth noting at this point that direct quantitative estimation of such adsorption by the Gibbs equation (4) cannot be reliably made for foams, even without reflux. The Gibbs equation applies to conditions of true equilibrium, which of course do not exist at the mobile surface of a foam bubble.

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References and Notes

- 1. L. Shedlovsky, Ann. N.Y. Acad. Sci 49, 279 (1948).
- For an interesting exception, see R. W. Schnepf, E. L. Gaden, Jr., E. Y. Mirocznik, and E. Schonfeld, Chem. Eng. progr. 55, No. 5, 42 (1959).
- 42 (1959).
 This work is supported by a U.S. Public Health Service grant (RG-5870). We also thank E. L. Gaden, Jr., of Columbia Univer-sity, for his suggestions concerning the foam breaker and the choice of Aresket-300.
 S. Glasstone, Textbook of Physical Chemistry (Van Nostrand, New York, ed. 2, 1946), p. 1206.

27 February 1961

Critical Factors in Successful Recovery of Rous Sarcoma **Virus from Turkey Tumors**

Abstract. Studies of tumor cell cultures with antiviral antibody showed that most of the cell-associated virus and viral antigen were found at the cell membrane and were thus accessible to the effect of neutralizing antibody. Humoral antibody present in tumor tissue neutralized cellassociated virus in vivo and thus rendered the tumor cells temporarily noninfectious. When these cells were grown in vitro in the absence of antibody, virus eventually reappeared. However, the time of reappearance, amount of virus produced, and persistence of virus in such cultures depended upon the amount of virus used to produce the tumor.

Electron microscope studies (1) have shown that virus particles are extracytoplasmic and are located at the cell membranes and in vacuoles of chicken sarcoma cells. When such cells were stained with fluorescent antiviral antibody, viral antigen was located mainly at the cell membrane and in the cytoplasm (2). Our studies with fluoresceinlabeled (3), as well as unlabeled, turkey antiviral antibody revealed the following picture with turkey sarcoma cells in culture: In fluorescent antibody stained cells the bulk of the antigen was found at the cell membrane with much less in the cytoplasm and vacuoles. However, when cells were grown in the presence of antiviral antibody and washed extensively with saline, only a few cells showed finely granular fluorescence in the cytoplasm and none at the cell membrane. In addition, such cells, when sonically disrupted, always contained less than 10 percent of the amount of infectious virus found in comparable numbers of tumor cells grown in the absence of antiviral antibody-for example, 1.7 log EDso as compared to 4.0 log ED50. Thus, infectious virus associated with tumor cells is mainly extracytoplasmic and consequently is accessible to circulating antibody.

The amount of virus recoverable from homogenates of tumor tissue from both chickens (4, 5) and turkeys (6) was found to be directly related to the infecting dose and varied greatly even within the same dose group. In the latter instance, failure to recover virus was frequently associated with the presence of antiviral antibody (6). The studies described below (7) show that virus can be successfully recovered from such noninfectious tumors when the tumor cells were grown in tissue culture in the absence of antibody. Briefly, our

Table 1. Selected examples of the effect of antibody and infecting dose on recovery of virus from turkey tumors. All numbers are logarithms.

Infecting dose*	Serum† neutral- ization titer	Infectivity titer* of						
		homog- tumo	Washed tumor	Tissue culture supernatant collected on day:				*
			cells§	2	8	22	36	50
4.3	0.1	> 5.7	4.4	3.7	4.0	3.0	3.8	3.2
4.3	2.9	< 0.3	< 0.3	< 0.3	4.0	3.0	3.0	2.8
0.3	2.5	< 0.3	1.1	< 0.3	3.9	< 0.3	2.0	< 0.3
0.3	2.3	< 0.3	0.4	< 0.3	2.4	< 0.3	< 0.3	< 0.3
0.03	3.4	< 0.3	< 0.3	0.6	< 0.3	< 0.3	< 0.3	1.0
0.3	2.5	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	1.1	0.6

* ED₅₀ per milliliter. † Diluted 1:10. ± 10 percent tumor tissue extract. 8 Sonically disrupted cells obtained from trypsinized tumor tissue,

procedure was as follows: 0.2-ml amounts of suitably diluted standard virus (8) were injected into the wing web of turkeys 5 to 7 days old. At various times after infection, the birds were bled and their tumors were dissected. Each tumor and serum was processed individually. All infectivity titrations and serum neutralization tests (6) were carried out in eggs, by using an improved pock-counting technique (9). Each serum was inactivated (56°C for 30 min) and assayed for the presence of antiviral antibody. The tumor was washed and minced. Part of the tissue was homogenized as a 10-percent suspension and titrated for infectivity. The remainder of the tumor tissue was washed thrice with balanced salt solution and exposed to 0.25 percent trypsin at 37°C for 1 hr. The resulting cell suspension was washed thrice and resuspended in complete medium (10) to a concentration of 1 × 10^s cells per milliliter. A sample was removed for sonic oscillation and subsequent infectivity titration. The cells were then distributed into bottles and incubated at 40°C. The cultures were fed twice a week, and culture supernatants were collected at intervals and assayed for infectivity. Under these conditions, the cells of most tumors grew well for as long as 2 to 3 mo and were subcultured at intervals of 1 to 3 wk.

The data in Table 1 show that, even when tumors were produced with large amounts of virus, circulating antibody, when present, not only rendered tumor homogenates noninfectious but also neutralized virus associated with intact cells. Large numbers of such cells, when washed free of antibody and sonically disrupted, were noninfectious. Inoculation of the same numbers of intact cells gave similar results. The data further show that several days in an antibody-free environment were required for the cells to produce sufficient

quantities of new virus to permit successful recovery. When small amounts of virus were used to produce tumors, virus was eventually released in low titer and in an unpredictable and intermittent fashion in cell cultures from each of 14 turkey tumors and three chicken tumors analyzed. Several cultures of trypsinized normal wing web cells from tumor-bearing turkeys were carried in tissue culture along with the tumor cell cultures and were tested for the presence of virus at the same time as the latter. None were positive, although these cultures were fully susceptible to infection. The previous report (5) of failure to recover virus in vitro from noninfectious chicken tumors was probably due to suboptimal conditions of cell cultivation. It is hoped that these findings will be of value in efforts to isolate oncogenic viruses from naturally occurring tumors in man and other animals.

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References and Notes

- 1. W. H. Gaylord, Jr., Cancer Research 15,
- W. H. Gaylord, Jr., Cancer Research 18, 80 (1955); F. Hagenau, A. J. Dalton, J. B. Moloney, J. Natl. Cancer Inst. 20, 633 (1958).
 R. A. Malmgren, M. A. Fink, W. Mills, *ibid.* 24, 995 (1960); R. C. Mellors and J. S. Munroe, J. Exptl. Med. 112, 963 (1960).
 J. D. Marshall, W. C. Eveland, C. W. Smith, Proc. Soc. Exptl. Biol. Med. 98, 898 (1958).
 W. P. Bryan, D. Colann, L. B. Moloney.
- Froc. Soc. Expir. Biol. Med. 96, 696 (1936). W. R. Bryan, D. Calnan, J. B. Moloney, J. Natl. Cancer Inst. 16, 317 (1955). A. M. Prince, ibid. 23, 1361 (1959). F. J. Rauscher and V. Groupé, ibid. 25, 141
- (1960)
- 7. These studies were supported by grants from

- These studies were supported by grants from
 the American Cancer Society and the National Cancer Institute.
 W. R. Bryan, J. B. Moloney, D. Calnan,
 J. Natl. Cancer Inst. 15, 315 (1954).
 V. Groupé, V. C. Dunkel, R. A. Ma:aker,
 J. Bacteriol. 74, 409 (1957).
 The medium consisted of the following.
 Scherer's maintenance solution, 68 percent:
 tryptose phosphate broth (Difco), 20 percent;
 inactivated calf serum. 10 necessity beef emtrypiose phosphate broth (Dirco), 20 percent, inactivated calf serum, 10 percent; beef embryo extract, 2 percent; penicillin G, 100 units per milliliter; streptomycin, 100 µg/ml; pH adjusted to 7.6 with 7.5-percent sodium bicarbonate solution.
- 7 April 1961

Seasonal Changes in Osmotic Pressure of Flounder Sera

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Abstract. The freezing point depression of sera collected from flounder during the winter averaged 1.15°C, whereas it averaged 0.63°C for sera collected during the summer. Elevated concentration of sodium and chloride ions were found for the winter samples of sera, but NaCl explained only a fraction of the seasonal increase in osmolarity.

During the winter of 1958-59, when temperatures of as low as -0.8°C were recorded in the bottom waters of the Mystic River estuary in eastern Connecticut, adult winter flounder, Pseudopleuronectes americanus (Walbaum), were observed to migrate into the estuary to spawn. Experiments during this season on minimum temperature tolerance indicated that death, which was accompanied by freezing of tissues, occurred in the fish between -1.0° and -1.5°C; these are abnormally low temperatures in view of the usual range of freezing points of teleost blood, from -0.5° to -0.8° C (1).

These observations led to investigation of the osmotic pressure (as determined by freezing point) of flounder sera in the winter, and to a comparison with that found in the summer. Flounder in both seasons were collected within the estuary, where the salinity was 22 to 30 per mil. Most of the fish collected in the winter were ripe adults, which do not normally feed prior to spawning; the flesh of these fish was soft and watery compared with that of fish collected in the summer. Blood was obtained by heart puncture from fish 24 to 44 cm long, during the periods June-August 1959 and January-February, 1959 and 1960. Heparinized blood samples were centrifuged at 500 rev/min for 5 min. Each serum sample was pipetted into a Pyrex vial, which was sealed and stored in a deep-freezer. The osmolarity of serum samples was measured with a Fiske osmometer in January 1960.

There was a striking seasonal difference in the osmotic pressure of flounder sera. The average freezing-point depression for 18 fish collected in the winter, including those collected in the relatively mild winter of 1959–60, was 1.15°C (S.D., 0.13), a finding in agreement with the indications of tolerance experiments. In contrast, the freezing point depression for sera from 19 fish collected in the summer was significantly lower, 0.63°C (S.D., 0.04), and within the range of osmolarity for "normal" marine teleosts.

Since chloride and sodium ions are principal electrolytes in fish blood, analyses were made to determine to what extent they contributed to the seasonal differences in serum osmolarity. Analysis for chloride was made through a microadaptation of the method of Schales and Schales as proposed by Burden (2), in which 5 mm³ of serum and 50 mm⁸ of indicator solution were transferred into titration tubes with the aid of constriction pipettes. Titrations were made without deproteinization by means of a microburette and magnetic stirrers. The accuracy of this method was checked through analyses in which standard sodium chloride solutions and clinical human serum of known chloride content were used. Sodium concentration was determined with a Beckman DU spectrophotometer with a flame attachment. Serum solutions and standards (0.2 to 1.6 percent NaCl) were mixed with 0.02 Sterox in the proportion of 1 to 500. A blank and a clinical serum standard were run for each fish-serum determination. The variation in replicate determinations averaged 5 percent for the sodium and 2 percent for the chloride.

Although variable, the results of the chloride and sodium analyses (Fig. 1) showed clear seasonal differences. The concentrations of both were higher in the winter. The mean difference between the chloride and the sodium contents for individual fish was not significant for fish collected in the summer (t = 1.8, 19 degrees of freedom), but the difference was significant for those collected in the winter (t = 4.4, 12 degrees of freedom); hence higher levels of sodium than chloride are indicated during the winter.

Osmolarity and concentration of sodium chloride (based on concentration of chloride) are plotted for individual fish in Fig. 2. Even though there was an elevation of sodium chloride in winter, this accounts for only a portion of the winter increase in osmotic pressure. Whereas an average of 83 percent of the total osmolarity for sera collected in the summer was accounted for by sodium chloride, only 57 percent of the winter total was attributable to sodium chloride. In other words, most of the increased osmolarity (about 0.4°C or 0.2M) was due to the presence of other substances.

These results for the winter flounder are very similar to results reported by Scholander et al. (3) for two species of fishes living near the surface in

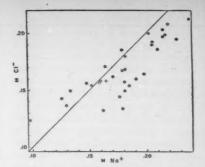


Fig. 1. Molarity of flounder sera, based on concentrations of chloride and sodium in samples collected in winter (solid circles) and summer (open circles). The diagonal line represents equivalent molarities.

an arctic fjord; for these fish the freezing point of blood was -0.7° to -0.9°C in the summer and -1.3° to -1.6°C in the winter. Levels of sodium chloride (based on levels of chloride) accounted for about 80 percent of the total osmolarity in the summer but for only about 50 percent in the winter.

Although Woodhead and Woodhead (4) did not report such distinct seasonal changes in the total osmotic pressure in sera from the Atlantic cod, elevations in concentrations of sodium and chloride were found in cod captured in the winter from water below 2°C. They interpreted these seasonal changes in levels of sodium and chloride as being due to a breakdown of the osmoregulatory ability at low water temperatures in the winter. (Other factors are postulated to explain the apparent lack of osmotic imbalance at low temperatures during the summer.)

If the seasonal changes in osmolarity reported here and by Scholander et al. were in fact due to osmoregulatory failure in the winter, as suggested by

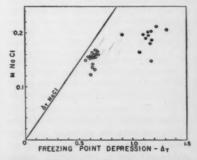


Fig. 2. Freezing point depression in degrees centigrade, and molarity of sodium chloride (based on concentration of chloride) of flounder sera collected in winter (solid circles) and summer (open circles).

Woodhead and Woodhead, then we would expect that the main increase in osmolarity could be ascribed to an increase in sodium chloride, the major sea-water salt. However, sodium chloride explained only a part of the difference in osmotic pressure, and the proportion of the total osmotic pressure due to sodium chloride decreased in the winter (see Fig. 2). Therefore the theory of osmotic imbalance does not appear to offer a complete explanation of the results of all these studies. As suggested by Scholander et al., the high osmotic pressure may have some adaptive significance as a protection against freezing for fishes inhabiting cold. shallow waters (5).

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References and Notes

- 1. V. S. Black, Publs. Ont. Fisheries Research Lab. No. 71 (1951).
- Lab. No. 71 (1951).
 C. E. Burden, Biol. Bull. 110, 13 (1956).
 P. F. Scholander, L. Van Dam, J. W. Kanwisher, H. T. Hammel, M. S. Gordon, J. Cellular Comp. Physiol. 49, 5 (1957).
 P. M. J. Woodhead and A. D. Woodhead, Proc. Zool. Soc. London 133, 181 (1959).
 I wish to thank G. E. Pickford for the use of equipment, and for comments and the meaning of the processing of the property and for comments and the meaning of the processing o
- equipment and for comments on the manuscript and D. H. Barron for use of the Fiske osmometer. This research was supported in part by the U.S. Public Health Service (contract No. EF-10,632).
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10 April 1961

First-Year Breakdown of Leaf Litter in Southern Appalachian Forests

Abstract. Breakdown of organic matter, an important step in the ecological circulation of chemical elements, was measured in Great Smoky Mountain and Oak Ridge forests. Greatest variation in first-year weight loss of leaves in nylon net bags was due to species (Fagus grandifolia 21 percent, Acer saccharum 32 percent, Quercus shumardii 34 percent, Quercus alba 39 percent, Morus rubra 64 percent). At elevations of 5200, 3400, and 850 ft, losses for all five species averaged, respectively, 29, 34, and 40 percent for leaves placed in spruce, hemlock, and pine stands, and 35, 40, and 46 percent for leaves placed in beech, cove hardwood, and whiteoak stands.

The Southern Appalachian forests have long attracted attention for their floristic diversity and complexity of vegetation pattern (1), but the opportunities which they offer for the study of ecological processes in contrasting natural environments deserve at least as much attention. The first-year results

in a long-term experiment show remarkably systematic effects of contrasting climate, forest cover (evergreen versus deciduous), and species of leaf on the rates of breakdown of leaves on the forest floor. Such differences influence the release of nutrients to the soil and their availability to growing plants. The rate of this cycling of chemical elements from plants to litter to soil and back to plants is important in relation to the metabolism of the ecological system and to the movement through this system of radioactive isotopes originating from fallout and radioactive waste disposal operations (2-5).

Forests in the Great Smoky Mountains and at Oak Ridge have already been shown to exhibit a great range in accumulation of litter and humus (6). The differences are presumably due more to contrasting rates of breakdown than to variations in productivity (3, 4, 7). Differences in breakdown are influenced by both the litter species and the environment in which the litter is decomposing-factors which are confounded under natural conditions. The present study was designed to isolate the effects of these factors. Weighed samples of recently fallen leaves of five deciduous tree species were placed in bags of nylon net in paired deciduous and evergreen forest stands typical of three contrasting altitudinal climatic belts of the Southern Appalachian region (1, 8).

Of the field procedures previously used (9-11), that of Bocock and Gilbert (10) was most similar to ours, but we used larger samples in bags of smaller mesh size. The nylon net with 2.3-mm holes was fine enough to restrict loss of leaf fragments, yet coarse enough to admit a rich litter fauna (12). Rectangular net bags, 45 by 60 cm, were loaded with 50-g samples of leaves from large air-dried homogeneous supplies collected, soon after falling, at Oak Ridge (mulberry, Morus rubra L.; sugar maple, Acer saccharum Marsh.; Shumard red oak, Quercus shumardii Buckley), at Knoxville (white oak, Quercus alba L.), or at the beech stand where one set of litter bags was placed (beech, Fagus grandifolia Ehrh.). A safety pin closed the bag and attached it to a stainless steel nail anchored in the forest floor. The 50 g of leaves were well distributed initially over approximately 40 by 50 cm, but slow downhill creep tended to reduce this area by the end of the year.

In mid-December 1958, five bags

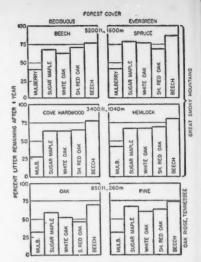


Fig. 1. Leaf litter from five tree species at end of first year, in six Southern Appalachian forests (evergreen versus deciduous stands at three elevations).

were distributed in each of four ramdomized blocks in each of the six forest stands, only one block being used in the study here reported. During early inspections at approximately monthly intervals, most herbs (Claytonia, Oxalis, Stellaria) growing into the bags were gently pulled out; any remaining herbs or other extraneous materials (spruce or hemlock needles) were removed before final weighing. After 51/2 mo, one set of bags was dried on Tullgren funnels for extraction of the soil fauna (12), weighed air dry (30 percent relative humidity), and returned to the field in less than 2 wk (4). Extraction of the fauna, removal of extraneous materials, and final weighing were carried out at the end of 12 mo on a full set of 30 samples (Fig. 1), and the samples were retained for chemical analysis. Other blocks were left for future collection and comparison with additional bags installed in 1959.

Analysis of variance and regression (Fig. 2) shows the main effects of all three variables to be highly significant. In the split plot analysis of variance in Fig. 2, "error I" (for effects between stands) happens to be smaller than "error II" (for comparisons of leaf species within stands), but the main effects are highly significant with respect to either estimate of error. Interactions of altitude and forest cover, leaf species and cover, and species and altitude are not statistically significant (F < 1) and are far smaller than the main effects.

Effect of altitude is linear (2.4 percent difference in rate of breakdown per 1000 ft elevation or approximately 1 percent per degree Fahrenheit) with nonsignificant difference in regression slope between deciduous and evergreen forests. This compares closely with Mikola's differences of 1.75 percent per degree centigrade in first-year breakdown of pine needles in pine and spruce forests of northern and southern Finland, but is slightly less than the difference of 2.4 percent per degree centigrade for birch leaves (13). The consistent difference in percentage breakdown between evergreen and deciduous forests is about 6 percent, a difference slightly greater than would be expected from the microclimatic temperature records (14). It remains to be seen to what degree the differences between these contrasting adjacent stands are due to their microclimate and to what degree due to differences in microbiology.

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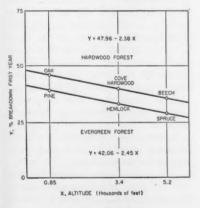
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Species differences were highly significant (Fig. 2) and consistent (Fig. 1). Most beech leaves remained unfragmented for the full year, with their



ANALYSIS (OF VI	ARIANCE
SOURCE	d.f.	M.S.
COVER	1	282.14#
ALTITUDE	2	
LINEAR	1	556.0°
RESIDUAL	- 1	5.8
ERROR I	2	0.65
SPECIES	4	1471.7**
SP. x COVER	4	5.55
SP. x ALT.	8	5.57
ERROR II	8	20.54

"MIGHLY SIGNIFICANT WITH RESPECT TO EITHER ERROR ! OR

Fig. 2. Regression of percentage breakdown, averaged for five species of leaves, on altitude of three evergreen and three deciduous forest stands in which leaves were exposed for 1 yr; split plot analysis of variance showing highly significant effects of evergreen versus deciduous cover, altitude, and species. Deviations of plot means (circles) from fitted regression slopes are not significant. Error II may include high order interactions, but these are small compared with main effects.

degree of discoloration and perforation correlated with their weight losses (ranging from 12 percent under spruce to 29 percent under oak). Mulberry not only lost far more weight (57 to 68 percent), but the material remaining in the bags was rapidly darkening and losing form in only 4 mo. Aggregates of leaves had been changed by the end of the year to black masses of humus. which would have moved into the H or As layer of the soil if not confined in the bags. White oak, Shumard red oak, and sugar maple were intermediate between mulberry and beech in weight loss, discoloration, and fragmentation. Similar several-fold species differences in rates of breakdown have been shown in laboratory experiments and have been related to organic and inorganic chemistry of the leaves (15).

The surprisingly small difference between oak and sugar maple in litter bags, compared with more rapid disappearance of maple in certain natural forests, might be due to the absence or exclusion of large earthworms (10) which apparently select sugar maple when present in mixture with oak (11). Because of confinement of the leaves and their fragments, and restricted access of the larger forest floor fauna, the present results are not absolute measurements of breakdown of forest litter under natural conditions, but provide for estimates of relative rates under standardized conditions.

It remains to be seen whether losses in later years will show approximately constant percentage breakdown so that they fit theoretical models assuming linear differential equations with constant coefficients (4, 5, 7), or whether quantitative models for the development of forest floor material, the cycling of nutrients, and the dispersal of radioactive contamination will have to employ differential equations with variable coefficients (16).

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References and Notes

- 1. S. A. Cain, Bull. Torrey Botan. Club 70, 213 S. A. Cain, Bull. Torrey Botan. Club 70, 213 (1943); E. L. Braun, Deciduous Forests of Eastern North America (Blakiston, New York, 1950); R. H. Whittaker, Ecol. Monographs 26, 1 (1956).
 H. R. DeSelm and R. E. Shanks, Proc. IX Intern. Botan. Congr., Montreal, in press.
 J. S. Olson, Proc. IX Intern. Botan. Congr. 2, 287 (1959).

- Oak Ridge Natl. Lab. Rept No. ORNL 2806, 41–45 (1959).
 J. S. Olson, W. C. Cate, D. A. Crossley, Jr., M. P. Hoglund, R. B. Neel, H. D. Waller, M. Witkamp, J. P. Witherspoon, J. A. Wolfe, Oak Ridge Natl. Lab. Rept. No. ORNL 2994, 157, 1865 (1969).
- 167-185 (1960).

 6. J. T. McGinnis, thesis, University of Tennes-
- 167-185 (1960).
 6. J. T. McGinnis, thesis, University of Tennessee (1958).
 7. H. Jenny, S. P. Gessel, F. T. Bingham, Soil Sci. 68, 419 (1949).
 8. R. E. Shanks, Ecology 35, 354 (1954).
 9. J. G. Falconer, J. W. Wright, H. W. Beall, Am. J. Botany 28, 196 (1933); H. A. Lunt, J. Forestry 33, 607 (1935); J. W. Johnston, Ir., thesis, Harvard University (1935); M. Ohmasa and K. Mori, Bull. For. Exptl. Sta. Tokyo-Fu 3, 39 (1937); A. Nömmik, Bodenk. u. Pflanzenernähr. 8, 77 (1938); W. Wittich, Forstarchiv 15, 96 (1939); ibid. 19, 1 (1943); F. G. Gustafson, Plant Physiol. 18, 704 (1943); B. B. Coldwell and W. A. DeLong, Sci. Agr. 30, 456 (1950); P. Mikola, Communs. Inst. Forest. Fenn. 43, 1 (1954); C. Kucera, Ecology 40, 485 (1959); M. Witkamp, Mededel. Inst. Toegepast Biol. Onderzoek. Nat. 46, 1 (1960); and J. Van der Drift, Plant and Soil, in press; P. W. Murphy, in preparation.
- Dritt, Plant and Soil, in press; P. W. Murphy, in preparation.

 10. K. L. Bocock and O. J. W. Gilbert, Plant and Soil 9, 179 (1977); K. L. Bocock, O. J. W. Gilbert, C. K. Capstick, D. C. Twinn, J. S. Waid, M. J. Woodman, J. Soil Sci. 11, 1 (1960).

- (1960).
 C. E. Olmsted, unpublished experiments at Lake Geneva, Wis.
 D. A. Crossley, Jr., unpublished data, Oak Ridge National Laboratory.
 P. Mikola, Oikos 11, 161 (1960).
 R. E. Shanks, Ecology 37, 1 (1956).
 E. Melin, ibid. 11, 72 (1930); W. M. Broadfoot and W. H. Pierre, Soil Sci. 48, 329 (1939).
 This work is contribution.
- This work is contribution N. Ser. 221 from the Botanical Laboratory, University of Tenessee, and contribution 38 from the Ecology Section of the Oak Ridge National Laboratory; it was supported by contract No. AEC AT-(40-1)-2077 with the Environmental Sciences Branch, Division of Biology and Medicine, U.S. Atomic Energy Com-mission, and by contract No. W-7405-eng-26 with the Commission. Operated by Union Carbide Corporation for
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- 10 April 1961

A New Thiamine Derivative, S-Benzoylthiamine O-Monophosphate

Abstract. S-Benzoylthiamine O-monophosphate has been synthesized, and its physicochemical and biological properties have been investigated. It is a stable crystalline substance, it exerts thiamine activity approximately equivalent to that of thiamine hydrochloride in thiamine-requiring microorganisms, and it is easily absorbed in organisms, particularly by oral administration.

Recently, Fujiwara and others (1) reported on thiamine alkyldisulfides, including thiamine propyldisulfide, which were absorbed in organisms more easily than thiamine hydrochloride. In the course of studies on phosphoric acid derivatives of thiamine, we found that a new derivative of thiamine monophosphate, S-benzoylthiamine O-monophosphate (BTMP), exhibited similar ease in absorbability in organisms by oral

S-Benzoylthiamine O-monophosphate,

Fig. 1. Chemical structure of BTMP.

C19H22O6N4SP, molecular weight of 466.47, has the chemical structure shown in Fig. 1. It is a colorless, odorless, crystalline substance of prism form, which melts at about 195°C with decomposition. It is sparingly soluble in benzene, chloroform, dioxane, pyridine, ethanol, and methanol and readily soluble in glacial acetic acid. Its solubilities in water are 0.004 g/ml at pH 4.05 and more than 1 g/ml at pH 8.0, the former pH corresponding to its isoelectric point. Although it is an amphoteric substance, as are protein and amino acids, it is almost nonhygroscopic. When crystals were exposed directly to the sun in air for a period of 23 days to observe coloring, almost no coloring was produced as compared to the con-

The compound is very stable in aqueous solutions under acid conditions, as expected from the chemical structure. An aqueous solution in a concentration of 5 mg/ml was heated at 100°C at various pH's, with the result that more than 90 percent of the initial amount remained undecomposed at a pH between 1.0 and 5.6 after 2 hr.

It has a thiamine potency in microorganisms and animals at least as high as an equimolar amount of thiamine hydrochloride. It is more easily absorbed in the body than thiamine hydrochloride, and administration results in higher thiamine and cocarboxylase levels in organs; moreover, these levels last for a longer period of time. This characteristic is particularly remarkable when the compound is administered orally. It does not cause any unfavorable symptom in animals such as thiamine hydrochloride does (the LD₅₀ of the former is larger than that of the latter), especially after intravenous and intraperitoneal injections.

The new derivative exerted thiamine activity approximately equivalent to thiamine hydrochloride in a microorganism, Lactobacillus fermenti 36, in birds, Uroloncha striata var. domestica, and in a pigeon.

As aneurinase I, a culture broth of *Bacillus thiaminolyticus* Matsukawa et Misawa (species MM) was used, and as aneurinase II that of *B. aneurinolyticus* Kimura et Aoyama (species KA). The remaining thiamine activity was measured after incubation at *pH* 7.5 at 37°C for 2 hr, with the result that 97.3 and 95.3 percent, respectively, remained with aneurinases I and II. The thiamine activities in the case of thiamine hydrochloride were 57.0 and 65.2 percent, respectively.

The LD₅₀ by oral administration in mice, dd-strain hybrid, weighing 14 to 16 g was 15 g/kg of body weight (95 percent confidence limit, 13.3 to 16.9 g/kg) (compare 9 g/kg for thiamine hydrochloride), calculated according to the method of Litchfield and Wilcoxon (2). The LD50 by intravenous injection in male mice, dd-strain hybrid, weighing 14 to 16 g, was 2.2 g/kg of body weight (thiamine hydrochloride, 0.1 g/kg). The LD50 by intraperitoneal injection in female mice, dd-strain, weighing 16 to 18 g, was 1.81 g/kg of body weight. In cats anesthetized with pentobarbital. spinal injection BTMP at doses from 0.1 to 0.3 mg/kg

Table 2. Urinary thiamine exerction in human beings 24 hr after oral administration of Sbenzoylthiamine O-monophosphate and thiamine hydrochloride at various doses (in milligrams).

۰	,				
	5 mg	15 mg	25 mg	50 mg	100 mg
	S-	Benzoylthi	iamine O-	monophos	phate
	1.72	3.17	5.83	11.92	22.30
		Thian	nine hydro	chloride	
	1.45	1.68	1.94	2.17	2.90

of body weight caused almost no change in respiration or blood pressure; even at larger doses (as much as 0.5 to 1.2 mg/kg of body weight) BTMP did not produce any remarkable reaction, although in a few cases the rise or fall of blood pressure and the increase or expiration of respiration were noted in the same way as with thiamine hydrochloride.

The total thiamine levels in blood in dogs after oral administration of various amounts of BTMP and the urinary thiamine excretion in human beings after oral administration are illustrated in Tables 1 and 2 in comparison with results for thiamine hydrochloride. The thiamine assay was conducted according to the method of Fujiwara and Matsui (3). The doses in the tables are expressed by the amount of thiamine hydrochloride equimolar to the given amount of BTMP. Blood cocarboxylase levels determined according to the method of Kay et al. (4) were higher after administration of BTMP through various routes than after administration of hydrochloride in equimolar amounts.

Investigations of the therapeutic applications of BTMP are in progress in various hospitals in Japan (5).

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Table 1. Total thiamine levels in blood in dogs, after oral administration of S-benzoylthiamine O-monophosphate and thiamine hydrochloride.

Dose		· T	hiamine level (ug/100 ml)				
	Before		Hours after administration					
weight)	administration	1	2	4	6	10		
		S-Benzovlthia	amine O-monop	hosphate				
1	7.3	43.3	28.1	18.1	16.5	14.2		
3	7.7	109.3	87.0	59.2	43.7	30.5		
		Thiam	ine hydrochlor	ide				
1	7.0	18.0	12.0	10.0	7.6	7.1		
3	8.0	26.7	22.4	14.7	12.0	8.1		

References and Notes

- M. Fujiwara and H. Watanabe, Proc. Japan Acad. 28, 156 (1952); T. Matsukawa, ibid. 28, 146 (1952).
- 2. J. T. Litchfield, Jr., and F. Wilcoxon, J. Pharmacol. Exptl. Therap. 96, 99 (1949).
 3. M. Fujiwara and K. Matsui, Anal. Chem. 25,
- 810 (1953). 4. W. W. Kay et al., Biochem. J. 62, 601 (1956).
- W. W. Kay et al., Biochem. J. 62, 601 (1956).
 A detailed report on the results of our study is in preparation.
- 21 December 1960

Association Affairs

Additional Program Notes, Hotel Headquarters, and Housing for the Denver Meeting

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The preliminary announcement of the third Denver meeting of the American Association for the Advancement of Science, to be held 26-31 December 1961 [Science 133, 1710 (26 May 1961)], was principally an outline of the many sessions of the 18 AAAS sections and of some 76 participating organizations. It was apparent not only that this year's meeting in downtown Denver will be well balanced in its coverage-with every principal field of science, from astronomy to zoology, well represented-but that the programs, including the special sessions, will be particularly attractive. Since virtually all the sessions will be held in one or another of four hotels located within a few blocks of each other, the meeting also will be a particularly convenient

Additional details of the program of this 128th AAAS meeting have come in since publication of the preliminary announcement. In several instances symposia have been expanded, speakers of prominence have accepted invitations, and program chairmen have raised their original attendance estimates. The following supplementary information about various programs can be announced at this time.

Special Sessions

26 December, evening. AAAS General Session, "Moving Frontiers of Science," part I. As announced previously, there will be two somewhat complementary lectures on materials: "Changing concepts of mineral raw materials in the national economy," by Howard A. Meyerhoff (executive director, Scientific Manpower Commission), and "The molecular designing of materials," by Arthur R. von Hippel (director, Laboratory for Insulation Research, Massachusetts Institute of Technology).

Harrison Brown (California Institute of Technology) will preside.

27 December, evening. As previously announced, the 29th John Wesley Powell lecture of the Southwestern and Rocky Mountain Division will be given by Glenn T. Seaborg (U.S. Atomic Energy Commission).

28 December, noon. The George Sarton Memorial Lecture, now a AAAS special session which is supported by the George Sarton Memorial Foundation, the History of Science Society, and the AAAS Section on History and Philosophy of Science, will probably follow a luncheon for Section L and its affiliated societies. This second George Sarton Memorial Lecture will be given by Joseph Kaplan (University of California, Los Angeles); Chauncey D. Leake (chairman, AAAS Board of Directors) will preside.

28 December, afternoon. AAAS General Session, "Moving Frontiers of Science," part II. In addition to Halton C. Arp (Mt. Wilson and Palomar Observatories), who will speak on "The evolution of stars and galaxies," as announced, there will be a second lecturer, E. W. Fager (Scripps Institution of Oceanography), whose general topic will be energy flow in ecological systems. Harrison Brown will preside.

29 December, evening. The annual joint address of the Society of the Sigma Xi and the United Chapters of Phi Beta Kappa will be given by Harrison Brown. After a brief intermission, the annual address of the Tau Beta Pi Association will be given.

30 December, evening. As announced, the National Geographic Society will have its annual illustrated lecture and film; this is usually a first showing.

Interdisciplinary Symposia

28 December, morning. Four interdisciplinary symposia in the physical, biological, and social sciences will be presented concurrently. Two of these will have additional or complementary

sessions on other days. The programs are as follows.

"Physics of the Upper Atmosphere," jointly sponsored by Sections B-Physics and D-Astronomy, cosponsored by the American Geophysical Union and the American Meteorological Society, and probably cosponsored by the American Astronomical Society, arranged by Stanley S. Ballard (University of Florida).

'Geochemical Evolution-the First Five Billion Years" (two sessions, the second to be held the morning of 29 December), sponsored by Section C-Chemistry, cosponsored by Section E-Geology and Geography and the American Geophysical Union, arranged by T. S. Lovering (U.S. Geological Survey, Denver). Titles and speakers are as follows: "The origin and evolution of the chemical elements," G. R. Burbidge (Yerkes Observatory, University of Chicago); "The origin of the planets and their atmospheres," George Gamow (University of Colorado); "Geochemical limitations and the origin of life," Philip Abelson (Geophysical Laboratory, Washington, D.C.); and "The geochemical evolution of the North American continental crust," A. E. J. Engel (University of California, La Jolla).

"Existing Levels of Radioactivity in Man and His Environment: Measurement and Significance," sponsored by Section Np-Pharmacy, cosponsored by Sections F-Zoological Sciences, G-Botanical Sciences, I-Psychology, N-Medical Sciences, Nd-Dentistry, and O-Agriculture, arranged by John E. Christian (Purdue). Among the speakers will be P. R. J. Burch (University of Leeds, England), whose topic will be "The relationship of existing radiation levels to carcinogenesis."

"Water and Climate," jointly sponsored by Section O-Agriculture and the Committee on Desert and Arid Zones Research of the Southwestern and Rocky Mountain Division, cosponsored by Sections E-Geology and Geography, K-Social and Economic Sciences, M-Engineering, and P-Industrial Science, by the American Meteorological Society, and probably by the American Geophysical Union, and arranged by Terah L. Smiley (University of Arizona). Tentative titles and speakers are as follows: "Climatography of the United States," Walter Orr Roberts (High Altitude Observatory, University of Colorado); "Water capture and methods of increasing supplies," John W. Harshbarger (University of Arizona); "Weather modification," Dwight B. Kline (U.S. Weather Bureau, Washington, D.C.); and "Legal aspects of a national water code," Frank J. Trelease (University of Wyoming).

General Sessions

The AAAS Cooperative Committee on the Teaching of Science and Mathematics, in addition to sponsoring the symposium on science teaching in grades kindergarten through nine, as previously announced, will be a joint sponsor, with Section Q-Education and the National Association for Research in Science Teaching, of a session of ten short papers on the Science Teaching Improvement Program, "Studies in Teacher Education."

Other Symposium Notes

Physics. The American Astronautical Society will sponsor three or four groups of invited papers, 29 and 30 December, on the fundamentals of space science, with speakers from leading centers. This program will be arranged by Marvin Pitkin (Martin Co., Denver).

The American Meteorological Society will be a cosponsor of the interdisciplinary symposia, "Physics of the Upper Atmosphere" and "Water and Climate," and, as announced, may sponsor a special program of invited and contributed papers.

Chemistry. Details of the symposia, of sessions for contributed papers, and of the Chemists' Mixer of Section C-Chemistry were announced previously. Section C will, in addition, cosponsor the four-session symposium, "Physiological and Biochemical Aspects of Human Genetics," of Section N-Medical Sciences, on 29 and 30 December.

Anthropology. Section H-Anthropology will also cosponsor the symposium "Physiological and Biochemical Aspects of Human Genetics." To its program, which was outlined previously, Section H has added the following symposia: "The Wetherill Mesa Project," arranged by Douglas Osborne (Mesa Verde National Park, Colorado) to be held on the afternoon of 29 December concurrently with Section H's symposium on the concept of race; and "Crossspecies Incest Behavior," arranged by Margaret Mead (American Museum of Natural History), to be held concurrently with Section H's symposium on applied anthropology.

Social and Economic Sciences. Details of the American Society of Criminology's panel, "Rural Crime Control," arranged by Gordon H. Barker (Uni-

versity of Colorado), are now available. Titles and speakers are as follows: "Crime and delinquency in rural areas -the difficulties and possibilities of legislation," H. Ted Rubin (House of Representatives. Colorado State Legislature); "Problems in the police control of rural crime," Vernon Hastings, Jr. (sheriff, Logan County, Colorado); "Examples of Indian criminality," Omer C. Stewart (University of Colorado); "Problems of judges and prosecutors in rural areas," Charles J. Simon (judge, El Paso County, Colorado); and "Crime among minorities in rural areas," W. Thomas Adams (director, State Industrial School for Boys, Golden, Colorado). An evaluation will be given by Clyde Vedder (Northern Illinois University), and Gordon H. Barker will be chairman of the panel.

History and Philosophy of Science. As previously announced, Section L-History and Philosophy of Science will have two sessions (26 and 29 December) on the history of science and eight sessions (26–30 December) on the philosophy of science. Plans for these eight sessions, arranged by Norwood Russell Hanson (Indiana University), have been considerably changed since the program appeared in the preliminary announcement, and therefore the revised program is presented here in its entirety.

Dr. Hanson will preside at Session I, "Empiricism and the Status of Theories." Paul K. Feyerabend (University of California, Berkeley) will speak on how to be a good empiricist; discussants will be George T. McClure (Southern Illinois University) and Wilfrid Sellars (Yale). Henry A. Finch will speak on theoretical fruitfulness as a measure of concepts; discussants will be Robert Sternfeld (State University of New York) and Ernest W. Adams (University of California, Berkeley).

Wilfrid Sellars will preside at Session II, "Prediction and Causality." Roger Buck (Indiana University) will speak on reflexive predictions; discussants will be Grover Maxwell (University of Minnesota) and Michael Scriven (Indiana University). The second paper of the session will be given by Dr. Scriven; his topic will be a workable concept of causation; discussants are William H. Dray (University of Toronto) and William Rozeboom (St. Olaf College).

Robert Sternfeld will preside at Session III, "History and Philosophy of Science." Edward Grant (Indiana University) will speak on hypotheses in late medieval and early modern science;

discussants will be Giorgio de Santillana (Massachusetts Institute of Technology) and Gerald Holton (Harvard). Nicholas Rescher (University of Pittsburgh) will speak on ethical problems within science; discussants will be Wolfgang Yourgrau (Smith) and Robert S. Cohen (Boston University).

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Session IV, "Conventionalism and Laws within Modern Physics," will be under the chairmanship of David Hawkins (University of Colorado). A. E. Woodruff (University of Chicago) will speak on philosophical aspects of quantum field theory; discussants will be Michael S. Watanabe (IBM Research Center and Columbia University) and Hilary Putnam (Princeton). Richard A. Mould (State University of New York) will speak on convention and the concept of state in physics; discussants will be Joseph Epstein (Amherst College) and Gerald Holton.

Session V, "Induction," will include Section L's vice-presidential address by Norwood Russell Hanson; his topic will be "Scientists and Logicians: A Confrontation." Before the address, Michael S. Watanabe will speak on a probabilistic view of inductive processes; discussants of the latter paper will be Adolf Grünbaum (University of Pittsburgh) and Herbert Feigl (Minnesota Center for Philosophy of Science). Wolfgang Yourgrau will preside.

Session VI, "Machines and Brains," will be presided over by Herbert Feigl. Hilary Putnam will speak on brains and behavior; discussants will be William Rozeboom and Newton Garver (University of Buffalo). David Hawkins will speak on "Design for a mind"; discussants will be Bruce Aune (Oberlin) and Peter Winch (University College of Swansea).

Kenneth Hammond (University of Colorado) will preside at Session VII, "Methodological Problems of the Social Sciences." Herbert Feigl will speak on "Reduction of psychology to neurophysiology?"; discussants will be Roger Buck and Merle Turner (San Diego State College). Richard Rudner (Michigan State University) will speak on some logical problems of sociology; discussants will be Benjamin Nelson (State University of New York) and Grover Maxwell.

Session VIII, "The Nature of Historical Explanation," will be presided over by Adolf Grünbaum. Alan Donagan (Indiana University) will speak on the present state of the Popper-Hempel thesis; discussants will be Benjamin Nelson and Nicholas Rescher. William

H. Dray will speak on causal judgment in history; the discussant will be Newton Garver.

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In addition, on 28 December there will be a luncheon for Section L and its affiliated societies, followed by the George Sarton Memorial Lecture (see Special Sessions).

Medical Sciences. Details of the foursession symposium, "Physiological and Biochemical Aspects of Human Genetics," of Section N-Medical Sciences are now available. The symposium, cosponsored by Sections C-Chemistry, H-Anthropology, and Nd-Dentistry, and arranged by Alexander G. Bearn (Rockefeller Institute) and Oscar Touster (Vanderbilt University School of Medicine), will be held 29 and 30 December. Speakers are as follows: part I, "Structure and specific action of DNA 1," Paul Doty (Harvard), J. Hurwitz (New York University), and A. E. Mirsky (Rockefeller Institute); part II, "Gene-protein relationships," session I, C. Baglioni (Massachusetts Institute of Technology), D. M. Bon-(La Jolla, California), G. D. Novelli (Oak Ridge National Laboratory), O. Smithies (University of Wisconsin), and E. L. Tatum (Rockefeller Institute), chairman; part III, "Geneprotein relationships," session II, R. Ceppelini (University of Turino, Italy), H. N. Kirkman (University of Oklahoma), A. G. Motulsky (University of Washington School of Medicine), and A. G. Steinberg (Western Reserve); part IV, "Tissue culture, immunological and evolutionary aspects," C. L. Markert (Johns Hopkins), R. D. Owen (California Institute of Technology), and T. T. Puck (University of Colorado Medical Center). On the afternoon of 30 December, John B. Youmans (American Medical Association) will give his vice-presidential address and the 17th Theobald Smith Award will be presented.

The Committee on Research of the American Psychiatric Association will sponsor a two-session symposium, "Genetics and Evolution in Relation to Human Behavior," arranged by David A. Hamburg (National Institute of Mental Health, Washington, D.C.) and held 27 December.

Dentistry. Additional information about Section Nd-Pharmacy's two-session symposium, 27 December, on dental genetics is now available. The symposium will be a follow-up of a recent symposium held in Bethesda (under the auspices of the National Institute of Dental Research and the Council of

Dental Research of the American Dental Association), which served to bring together ideas and information regarding the various approaches in the study of dental genetics. The first session at the Denver meeting will emphasize the problems involved, as well as solutions and materials available. After a section luncheon there will be a round-table discussion of the problems, by those who presented papers at the morning session. Speakers will be Carl J. Witkop, Jr., and Bertram Hanna (National Institutes of Health, Bethesda); Stanley Garn (Fells Institute, Yellow Springs, Ohio); Robert Gorlin (University of Minnesota); Sidney L. Horowitz (Columbia University and New York University); Shirley Glasstone Hughes (Strangeways Laboratories, Cambridge, England); H. R. Hunt (Michigan State University); Jerome D. Niswander (University of Michigan); and Richard H. Osborne (Sloan-Kettering Institute for Cancer Research).

Education. Section Q-Education, the AAAS Cooperative Committee on the Teaching of Science and Mathematics, and the National Association of Research in Science Teaching plan a joint session of ten short papers on the Science Teaching Improvement Program, "Studies in Teacher Education."

The American Educational Research Association will have two sessions on 30 December; one will be devoted to an experimental program in applications of mental hygiene in the classroom; the other will be a broad treatment of methods, research, and applications of the latest automated procedures at several levels of education. This program, cosponsored by Section Q, will be arranged by Daniel D. Feder (University of Denver).

Local Committees

The Association, again this year, is fortunate in having an excellently qualified general chairman of the meeting and fortunate in the committee chairmen he has already appointed.

The general chairman is Robert L. Stearns, president of the Boettcher Foundation, formerly president of the University of Colorado.

The chairman of the Committee on Exhibits is Walter K. Koch, president of the Mountain States Telephone and Telegraph Company.

The chairman of the Committee on Finance is Carl A. Norgren, president of the C. A. Norgren Co. of Englewood, Colorado.

The Committee on Public Information

is under the co-chairmanship of Arthur G. Rippey, head of Rippey, Henderson, Bucknum & Co., and of Gerould A. Sabin, director of advertising, Colorado Fuel and Iron Corporation.

Shirley A. Johnson, Jr., director of the University of Denver Research Institute, is chairman of the Committee for Physical Arrangements.

The Advisory Committee is made up of the chairmen named above and of an additional member, Chester M. Alter, a fellow of the Association, who had begun to serve as a committee chairman for the 1953 Boston meeting when he was called to the chancellorship of the University of Denver.

Housing

The four hotels for the AAAS meeting have established special low rates for blocks of rooms for AAAS members and others attending the meeting. Thus, everyone who makes room reservations through the Housing Bureau can be assured of substantial savings.

Beginning with this issue, the advertising pages of Science will carry, at frequent intervals, announcements of hotel accommodations and rates, together with a coupon to be filled out and sent, not to any hotel directly, but to the AAAS Housing Bureau in Denver. All applications for hotel rooms will be filled in the order of receipt. Those who apply early are assured of accommodations in the hotel of their first choice. Expenses can be reduced still further if two people share a room, or if three or more people share a suite. Upon request, all hotels will place comfortable rollaway beds in rooms or suites at \$3 per night.

Registration

Both the technical, or program, sessions and the special sessions are open to all interested persons. Although registration for these sessions is not mandatory, undoubtedly all who attend will wish to pay the AAAS registration fee of \$3 and thus contribute their proportionate share to the heavy expenses of the meeting. (The registration fee for the husband or wife of a registrant, if a second General Program is not required, is \$1.)

Each registrant receives the General Program, convention literature, a listing in the Visible Directory of Registrants, and a convention badge; the latter assures him all privileges of the meeting. The badge is required for admission to the large-scale exhibits and the AAAS Science Theatre.

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An announcement on advance registration, with a coupon, will also be found in the advertising pages of this issue and at intervals hereafter.

AAAS Headquarters

As stated in the preliminary announcement, the Denver Hilton will be hotel headquarters for the AAAS as a whole. The Hilton, with its large ballroom and other session rooms, will accommodate the evening events, the general sessions, the AAAS business sessions, and the AAAS Pressroom. It will also house the AAAS Main Registration-Information Center, the AAAS Office, the Visible Directory of Registrants, the Annual Exposition of Science and Industry, and the AAAS Science Theatre.

The Hilton will also accommodate the American Society of Zoologists, the Society of Protozoologists, the Society of Systematic Zoology, Section N-Medical Sciences, the other biological and medical groups, and some of the physical sciences as well. The Shirley Savoy will be headquarters for the American Astronomical Society and the science teaching societies. The social and economic sciences will have headquarters at the Brown Palace and its new Tower annex. Finally, the Cosmopolitan is the headquarters hotel for the sections on dentistry, pharmacy, anthropology, and education for the American Astronautical Society, and, in part, for Section Q-Education and the science teaching societies.

A detailed list of the headquarters for each section and participating organization is given below.

Hotel Headquarters in Detail

AAAS sections are listed alphabetically, and societies are listed alphabetically by discipline.

Hilton (884 rooms), 155 Court Place.

AAAS Office; AAAS Pressroom; Main Registration-Information Center; Annual Exposition of Science and In-

dustry; AAAS Science Theatre; Visible Directory of Registrants.

AAAS (Board of Directors, Council); General Events and Special Sessions, AAAS Southwestern and Rocky Mountain Division.

AAAS Committee on the Public Understanding of Science; AAAS Committee on Science and the Promotion of Human Welfare; Committee on Desert and Arid Zones Research of the Southwestern and Rocky Mountain Division.

AAAS Sections A-Mathematics, C-Chemistry, E-Geology and Geography, F-Zoological Sciences, G-Botanical Sciences, M-Engineering, N-Medical Sciences, and O-Agriculture.

Association for Computing Machinery, Committee on the Undergraduate Program in Mathematics of the Mathematical Association of America, Society for Industrial and Applied Mathematics.

American Association of Clinical Chemists; American Chemical Society, Colorado Section.

Association of American Geographers, Great Plains-Rocky Mountain Division; Geological Society of America; National Geographic Society; National Speleological Society.

American Society of Zoologists, Society of Protozoologists, Society of Systematic Zoology.

American Society of Naturalists; Beta Beta Beta Biological Society; Biometric Society, Western North American Region; Ecological Society of America; Mountain Lake Biological Station; Nature Conservancy; Society of General Physiologists.

Engineering Manpower Commission, Tau Beta Pi Association.

Alpha Epsilon Delta.

American Geophysical Union, Conference on Scientific Communication, Conference on Scientific Manpower, National Academy of Sciences-National Research Council, National Association of Science Writers, National Science Foundation, Scientific Manpower Commission, Scientific Research Society of America, Sigma Delta Epsilon, Society of the Sigma Xi, United Chapters of Phi Beta Kappa.

Brown Palace and Tower (600 rooms), 17th Street and Tremont Place.

AAAS Sections I-Psychology, K-Social and Economic Sciences, L-History and Philosophy of Science, and P-Industrial Science.

American Economic Association,
American Political Science Association,
American Society of Criminology,
American Sociological Association,

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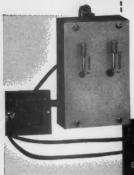
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National Association of Biology Teachers.

Colorado Science Teachers Association, Council for Exceptional Children, National Association for Research in Science Teaching, National Science Teachers Association.

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Forthcoming Events

August

13-18. Microchemical Techniques, intern. symp., University Park, Pa. (H. J. Francis, Jr., Pennsalt Chemical Corp., P.O. Box 4388, Chestnut Hill Post Office, Philadelphia 18, Pa.)

15-24. International Astronomical Union, 11th general assembly, Berkeley, Calif. (D. H. Sadler, Royal Greenwich Observatory, Hailsham, Sussex, England)

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16-18. Hypersonics Conf., intern., Cambridge, Mass. (J. J. Harford, American Rocket Soc., 500 Fifth Ave., New York, N.Y.)

18-21. Association of American Geographers, East Lansing, Mich. (M. F. Burrill, 1785 Massachusetts Ave., NW, Washington 6)

19-30. Agricultural Economists, 11th intern. conf., Cuernavaca, Mexico. (J. Ackerman, Farm Foundation, 600 S. Michigan Ave., Chicago, Ill.)

20-23. International Ergonomics Assoc., 1st congr., Stockholm, Sweden. (T. Olson, Dept. of Industrial Physiology, G.C.I. Lidingövägen 1, Stockholm)

20-24. American Veterinary Medical Assoc., Detroit, Mich. (H. E. Kingman, AVMA, 600 S. Michigan Ave., Chicago 5, Ill.)

21-23. International Hypersonics Conf., Cambridge, Mass. (F. Ridell, Avco Research Laboratory, 301 Lowell St., Wilmington, Mass.)

mington, Mass.)

21-24. Biological Photographic Assoc.,
Chicago, Ill. (Mrs. J. W. Crouch, Box
1668, Grand Central P.O., New York 17)

21-24. International Conf. on Photoconductivity, Ithaca, N.Y. (E. Burstein, Dept. of Physics, Univ. of Pennsylvania, Philadelphia)

21-26. International Congr. of Psychotherapy, 5th, Vienna, Austria. (W. Spiel, Lazarettg. 14, Vienna 9)
21-26. World Traffic Engineering Conf.,

21-26. World Traffic Engineering Conf., Washington, D.C. (Intern. Road Federation, 1023 Washington Bldg., Washington 5)

21-27. International Assoc. of Dental Students, congr., London, England. (D. H. Clark, Royal Dental Hospital, Leicester Sq., London, W.C.2)

21-31. United Nations Conf. on New Sources of Energy, Rome, Italy. (United Nations, New York, N.Y.)

21-2. International Congr. of Practical Medicine, Merano, Italy. (Bundesärtzte-kammer, 1 Hädenkampfstrasse, Cologne, Germany)

Germany)
21-6. Pacific Science Congr., 10th,
Honolulu, Hawaii. (Secretary General,
10th Pacific Science Congr., Bishop Museum. Honolulu)

22-25. International Pharmacological Meeting, 1st, Stockholm, Sweden. (A. Wretlind, Karolinska Institutet, Stockholm 60)

22-30. International Conf. on Protozoology, Prague, Czechoslovakia. (N. D. Levine, College of Veterinary Medicine, Univ. of Illinois, Urbana)

23-25. Gas Dynamics, symp., biennial, Evanston, Ill. (J. J. Harford, American Rocket Soc., 500 Fifth Ave., New York, N.Y.)

23-26. Electron Microscope Soc. of America, Pittsburgh, Pa. (Miss M. L. Rollins, Agricultural Research Service, U.S. Department of Agriculture, P.O. Box 19,687, New Orleans 19, La.)

23-26. Institute of Management Sciences, 8th annual intern., Brussels, Belgium. (W. Smith, Inst. of Science and Technology, Univ. of Michigan, Ann Arbor)



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23-1. Radioisotopes in the Biological Sciences, conf., Intern. Atomic Energy Agency, Vienna, Austria. (IAEA, 11 Kärtner Ring, Vienna 1)

24-26. Physiology of the Hippocampus, intern. colloquium, Montpellier, France. (Mme. Mineur, Centre National de la Recherche Scientifique, 13 Quai Anatole France, Paris 7)

26-1. Radiology, 10th intern. congr., Montreal, Canada. (C. B. Peirce, Suite 204, 1555 Summerhill, Montreal 25,

Canada)

27-29. International Congr. of Group Psychotherapy, 3rd, Paris, France. (W. Warner, P.O. Box 819, Grand Central Station, New York 17)

27-29. Psychosomatic Aspects of Neoplastic Disease, 2nd annual conv., Paris, France. (L. L. LeShan, Intern. Psychosomatic Cancer Study Group, 144 E. 90 St., New York 28) 27-1. American Congr. of Physical Medicine and Rehabilitation, Cleveland, Ohio. (D. C. Augustin, 30 N. Michigan Ave., Chicago 2, Ill.)

27-1. American Inst. of Biological Sciences, annual, Lafayette, Ind. (J. R. Olive, AIBS, 2000 P St., NW, Washington 6)

The following 26 societies are holding meetings in conjunction with the AIBS meeting at Purdue University.

Alpha Epsilon Delta (J. E. Wiebers, Dept. of Biological Sciences, Purdue Univ.)

American Bryological Soc. (S. N. Postlethwait, Dept. of Biological Sciences, Purdue Univ.)

American Fern Soc. (C. B. Heiser, Jr., Dept. of Botany, Indiana Univ., Bloomington)

American Fisheries Soc. (Miss S. Gerk-

ing, Dept. of Zoology, Indiana Univ., Bloomington)

American Microscopical Soc. (C. J. Goodnight, Dept. of Biological Sciences, Purdue Univ.)

American Soc. for Horticultural Science (R. G. Langston, Dept. of Horticulture, Purdue Univ.)

American Soc. of Limnology and Oceanography (C. J. Goodnight, Dept. of Biological Sciences, Purdue Univ.)

American Soc. of Parasitologists (S. M. Gaafar, Dept. of Veterinary Microbiology, Pathology and Public Health, Purdue Univ.)

American Soc. of Plant Physiologists (H. Beevers, Dept. of Biological Sciences, Purdue Univ.)

American Soc. of Plant Taxonomists (G. L. Webster, Dept. of Biological Sciences, Purdue Univ.)

American Soc. of Zoologists (M. X. Zarrow, Dept. of Biological Sciences, Purdue Univ.)

Association of Midwest College Biology Teachers (J. D. Novak, Dept. of Biological Sciences, Purdue Univ.)

Biometric Society (ENAR) (H. E. Mc-Kean, Statistical and Computing Laboratory, Purdue Univ.)

Botanical Soc. of America (A. C. Leopold, Dept. of Horticulture, Purdue Univ.)

Entomological Soc. of America (Section A) (L. Chandler, Dept. of Entomology, Purdue Univ.)

Genetics Soc. of America (A. B. Burdick, Dept. of Biological Sciences, Purdue Univ.)

Mycological Soc. of America (J. S. Lovett, Dept. of Biological Sciences, Purdue Univ.)

National Assoc. of Biology Teachers (J. D. Novak, Dept. of Biological Sciences, Purdue Univ.)

Nature Conservancy (A. A. Lindsey, Dept. of Biological Sciences, Purdue Univ.)

Phycological Soc. of America (A. T. Guard, Dept. of Biological Sciences, Purdue Univ.)

Sigma Delta Epsilon (Miss V. B. White, Dept. of Foods and Nutrition, Purdue

Society for Industrial Microbiology (W. N. Cannon, Lilly Research Laboratories, Eli Lilly and Co., Indianapolis, Ind.)

Society for the Study of Development and Growth (F. H. Wilt, Dept. of Biological Sciences, Purdue Univ.)

Society for the Study of Evolution (L. Chandler, Dept. of Entomology, Purdue Univ.)

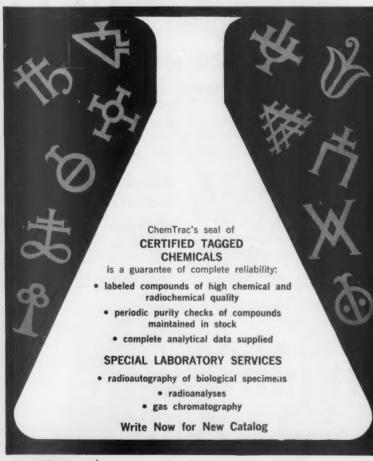
Tomato Genetics Cooperative (A. B. Burdick, Dept. of Biological Sciences, Purdue Univ.)

Wildlife Disease Assoc. (S. M. Gaafar, Dept. of Veterinary Microbiology, Pathology and Public Health, Purdue Univ.)

27-1. Coordination Chemistry, 6th intern. conf., Detroit, Mich. (S. Kirschner, Dept. of Chemistry, Wayne State Univ., Detroit 2)

28-30. Mathematical Assoc. of America, Stillwater, Okla. (H. L. Alder, MAA, Univ. of California, Davis)

28-30. Oak Ridge Inst. of Nuclear Studies, 8th annual summer symp., Gatlin-





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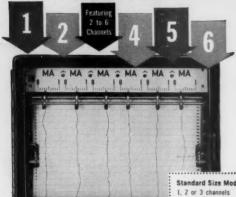
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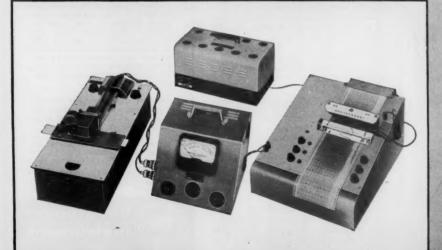
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28-30. Scandinavian Symp. on Fat Rancidity, 3rd, Sandefjord, Norway. (E. Törnudd, Gaustadallen 30, Blindern, Norway)

28-31. American Assoc. of Clinical Chemists, natl., New York, N.Y. (B. Klein, Chemistry Dept., Kingsbridge V.A. Hospital, Bronx, N.Y.)

28-31, American Soc. for Pharmacology and Experimental Therapeutics, Rochester, N.Y. (K. H. Beyer, Merck, Sharp and Dohme Research Laboratories, West Point, Pa.)

28-31. Botanical Soc. of America, Lafayette, Ind. (B. L. Turner, Dept. of Botany, Univ. of Texas, Austin 12) 28-31. Chemical Physics of Nonmetal-

28–31. Chemical Physics of Nonmetallic Crystals, intern. conf., Evanston, Ill. (O. C. Simpson, Argonne National Laboratory, 9700 South Cass Ave., Argonne, Ill.)

28-1. Heat Transfer Conf., intern., Boulder, Colo. (S. P. Kezios, American Soc. of Mechanical Engineers, 29 W. 39 St., New York 18)

28-1. Ionization Phenomena in Gases, 5th intern. conf., Munich, Germany. (Secretariat, Oskar von Miller Ring 18, P.O. 463, Munich 1)

28-1. Radioactive Metrology, symp., Oxford, England. (B. W. Robinson, Applied Physics Division, National Physical Laboratory, Teddington, Middlesex, England)

28-1. Rockets and Astronautics, 3rd intern. symp., Tokyo, Japan. (Japanese Rocket Soc., 1-3, Ginza-Nishi, Chuo-Ku, Tokyo)

28-2. European Soc. of Haematology, 8th congr., Vienna, Austria. (H. Fleischhracker, Frankgasse 8, Billrothhaus, Vienna 9)

28-2. International Assoc. of Medical Laboratory Technologists, general assembly, Stockholm, Sweden. (Miss M. Westenins, Statens Bakteriologiska Laboratorium, Box 764, Stockholm 1)
28-2. Detonation Waves, intern. collo-

28-2. Detonation Waves, intern. colloquium, Gif-sur-Yvette, France. (G. M. Ribaud, Centre National de la Recherche Scientifique, 13 Quai Anatole France, Paris 7, France)
28-2. Mechanics of Turbulence, intern.

28-2. Mechanics of Turbulence, intern. colloquium, Marseilles, France. (A. Favre, Faculté des Sciences, Université, Marseilles)

28-7. International Statistical Inst., 33rd session, Paris, France. (J. Berkson, Mayo Clinic, Rochester, Minn.)

29. American Soc. for Horticultural Science, Lafayette, Ind. (R. E. Marshall, Dept. of Horticulture, Michigan State Univ., East Lansing)

29-1. American Mathematical Soc., 66th summer meeting and 40th colloquium, Stillwater, Okla. (J. W. T. Youngs, AMS, 190 Hope St., Providence 6, R.I.)

29-1. Society for Industrial and Applied Mathematics, Stillwater, Okla. (G. Kaskey, Remington Rand UNIVAC, P.O. Box 500, Blue Bell, Pa.)

29-6. Planning of Experiments, intern. colloquium, Paris, France. (D. Dugue, Institut de Statistique de l'Université, 11 rue Pierre Curie, Paris 5)

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33rd session, Paris, France. (G. R. Chevry, 29 Quai Branly, Paris 7)

30-1. Semiconductor Conf., 3rd annual, Los Angeles, Calif. (W. V. Wright, Electro-Optical Systems, Inc., 125 N. Vinedo Ave., Pasadena, Calif.)

30-2. American Sociological Assoc., St. Louis, Mo. (T. Parsons, Dept. of Social Relations, Harvard Univ., Cambridge,

30-2. Experimental Research on Shell Structures, colloquium, Delft, Netherlands. (A. L. Bouma, Dept. of Civil Engineering, Technological Univ., Delft)

30-5. Mental Health, 6th intern. congr., Paris, France. (Miss E. M. Thornton, World Federation for Mental Health, 19 Manchester St., London, W.1, England)

31-2. Exfoliative Cytology, intern. congr., Vienna, Austria. (Office of the Secretary of the Congress, 666 Elm St., Buffalo 3, N.Y.)

31-2. Gynaecological Cytology, 1st intern. congr., Vienna, Austria. (R. M. Graham, Roswell Park Memorial Inst., 666 Elm St., Buffalo 3, N.Y.)

31-4. Preventive and Social Medicine, meeting, Evian, France. (Societé Française de Medecine Preventive et Sociale, 1 rue de Courcelles, Paris 8, France)

31-6. American Psychological Assoc., 69th annual, New York, N.Y. (J. G. Darley, 1333 16th St., NW, Washington 6)

September

² 1-5. Danube Research, intern. symp., Budapest, Hungary. (Biological Sciences Group, Hungarian Acad. of Sciences, Roosevelt Ter. 9, Budapest V)

1-9. Topology and Its Methods in Other Mathematical Disciplines, symp., Prague, Czechoslovakia. (Organizing Committee, Ke Karlovu 3, Prague 2)

1-10. International Pharmaceutical Students' Federation, 7th congr., Munich, Germany. (U. Peto, 10 Groffstr., Munich

2-7. International Assoc. for Quaternary Research, Warsaw, Poland. (R. Galon, Secretary General, INQUA, Geographical Inst. Univ., Torun, Poland)
2-9. International Soc. of Surgery, 19th

congr., Dublin, Ireland. (T. C. J. O'Connell, 35 Fitzwilliam Pl., Dublin)

3-7. International Assoc. for Hydraulic Research, 9th congr., Belgrade, Yugoslavia. (H. J. Schoemaker, Waterloopkundig Laboratorium, Raam 61, Delft, Netherlands)

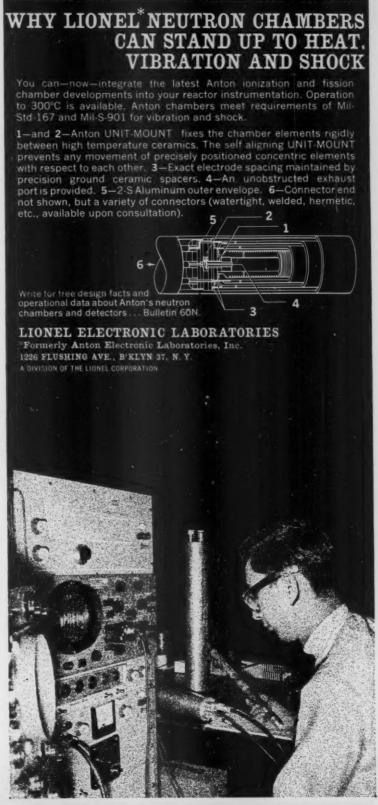
3-8. American Chemical Soc., 140th meeting, Chicago, Ill. (A. T. Windstead, National Meetings Dept., ACS, 1155 16 St., NW, Washington 6)

3-9. International Federation of Gynaecology and Obstetrics, 3rd world congr., Vienna, Austria. (V. Grünberger, Medizinische Akademie, Alserstrasse 4, Vienna

3-10. Inter-American Congr. of Radiology, 7th, São Paulo, Brazil. (W. Bomfim-Pontes, Rua Cesario Motta 112, São Paulo)

4. World Federation for Mental Health, 14th annual, Paris, France. (WFMH, 19 Manchester St., London, W.1, England)

4-6. International Assoc. for Shell Structures, colloquium, Brussels, Belgium. (Prof. Dutron, 127 Avenue Adolphe Buyl, Brussels 5)



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4-6. International Symp. on the Earth Storm, Kyoto, Japan. (T. Nagata, Science Council of Japan, Ueno Park, Tokyo)

4-7. Neuropathology, 4th intern. congr., Munich, Germany. (W. Haymaker, Armed Forces Inst. of Pathology, Walter Reed Army Medical Center, Washington 25)

4-7. Rheumatology, 10th intern. congr., Rome, Italy. (C. B. Ballabio, Clinica Medica Generale, Via F. Sforza 35, Milan,

4-8. Low Energy Nuclear intern. conf., Manchester, England. (L. J. B. Goldfarb, Physics Dept., Univ. of Manchester, Manchester)

4-8. Pharmaceutical Sciences, intern., congr., Pisa, Italy. (Intern. Pharmaceutical Federation, 11 Alexanderstraat, The Hague, Netherlands)

4-8 Plasma Physics and Controlled Nuclear Fusion Research, conf., Salzburg, Austria. (Intern. Atomic Energy Agency, United Nations, New York, N.Y.)

4-9. International Assoc. for Analog Computation, 3rd intern. sessions, Belgrade, Yugoslavia. (D. Strujic, Decanska 14/IV, Belgrade)

4-9. International Congr. of Angiology, 4th, Prague, Czechoslovakia. (Z. Reinis, 4th Medical Clinic, Prague 2/499)

4-9. International Symp. on Fundamental Problems in Turbulence and Their Relation to Geophysics (by invitation), Marseilles, France. (Intern. Union of Geodesy and Geophysics, 53 Avenue de Breteuil, Paris 7)

4-9. Laurentian Hormone Conf., Hoberg's Resort, Lake County, Calif. (Committee on Arrangement of the Laurentian Hormone Conference, 222 Maple Ave., Shrewsbury, Mass.)

4-13. Inter-African Conf. for Food and Nutrition, 4th, Bukavu, Congo Republic. (Commission for Technical Cooperation in Africa South of the Sahara, Pvt. Mail Bag 2359, Lagos, Nigeria)

4-14. Anglo-American Conf., 8th. London, England. (Inst. of Aerospace Sciences, 2 E. 64 St., New York.

5-8. International Congr. of Homeopathic Medicine, 25th, Amsterdam, Netherlands. (J. L. Fonteijn, Westzijde 116, Zaandam, Netherlands)

5-8. Machine Translation of Languages and Applied Language Analysis, intern. conf., Teddington, England. (L. Dostert, Director, Machine Translation Research, Georgetown Univ., 1715 Massachusetts Ave., NW, Washington 6)

5-8. National Chemical Exposition, 11th, Chicago, Ill. (Chicago Section, American Chemical Soc., 86 E. Randolph St., Chicago 1)

6-8. Effects of Ionizing Radiations on Immune Processes, intern. symp., Lawrence, Kan. (C. A. Leone, Dept. of Zoology, Univ. of Kansas, Lawrence)

6-8. Transmission and Processing of Information, intern. symp., Boston, Mass. (R. M. Fano, Research Laboratory of Electronics, Massachusetts Inst. of Tech-

nology, Cambridge 39) 6-12. Human Genetics, 2nd intern. conf., Rome, Italy. (L. Gedda, 5 Piazza

Galeno, Rome)

7-8. Pacific Slope Biochemical Conf., annual, San Diego, Calif. (R. G. Wolfe, Dept., Univ. of Oregon, Chemistry

7-9. International Cardiovascular Soc., 5th congr., Dublin, Ireland. (H. Haimovici, 715 Park Ave., New York 21)

7-9. Parapsychological Assoc., 4th annual congr., New York, N.Y. (W. A. Roll, Box 6116, College Station, Durham, N.C.)

7-11. European Orthodontic Soc., 37th congr., Bologna, Italy. (N. Gray, 16 College Rd., Eastbourne, Sussex, England)

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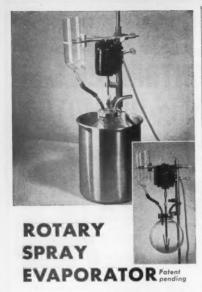
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16-20. German Soc. for the History of Medicine, Physical Science and Technology, Augsberg, Germany. (G. Mann. Secretary, Wilhelmplatz 7, Bonn, Germany)

16-27. International Scientific Film Assoc., 15th congr., Rabat, Morocco. (M. Afifi, 85 Ibn Toumert, Rabat)

18-2. World Meteorological Organization, Commission for Aerology, 3rd session, Rome, Italy. (WMO, 1 Avenue de la Paix, Geneva, Switzerland)

18-20. Applied Spectroscopy, 8th symp., Ottawa, Canada. (R. Lauzon, Div. of Pure Chemistry, National Research Council, Ottawa, Ont.)

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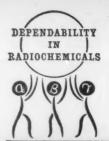
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Letters

Carbonate in Apatites

In view of the authenticity usually attributed to the subjects discussed at symposia of the AAAS, it seems essential to comment on the chapter by A. S. Posner in Calcification in Biological Systems (1).

Posner's summary (1, p. 391) states: "Detailed data on the role of carbonate in hard tissue are included with the view expressed that this ion is admixed with the major apatite phase as a second finely divided calcite phase in the various carbonatebearing apatites." Apparently the "detailed data" are those based on "preferential solubility" and the results obtained by several persons (1, p. 279) after heating various substances to various temperatures with variable results. The non sequiturs that are likely to arise from such experiments have been discussed by me (2).

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Posner cites his investigations with several co-workers to show (i) that it has been possible to delicately refine the atomic parameters of "pure hydroxyapatite," and elsewhere (ii) that it is possible to prepare synthetic calcium-deficient apatite in which one of four symmetrically equivalent Ca atoms is missing. Both conclusions necessarily involve precise calculations based upon the x-ray diffraction intensity measurements, as well as definite knowledge that one is dealing with a completely homogeneous phase of accurately known composition. Posner et al. do not give complete analytical data on major constituents (CaO, P2Os, and H₂O) for either set of experiments, and -far more important-they mention no tests to be certain that these precipitates were free from CO2. Their failure in the latter respect is particularly significant in view of the discovery by McConnell et al. (3) that the carbonate ion is essential to the formation of precipitates in systems approxiphysiological compositions. Comparisons of the many measurements of the unit cell dimensions of so-called hydroxyapatite (4) give rise to the question: Has pure (stoichiometric) hydroxyapatite ever been prepared? A corollary question is: How is it possible to obtain delicate refinement of the atomic parameters of something for which the composition is known solely by inference?

Far more important than these intricate details pertaining to "hydroxyapatite" are Posner's dismissals of contrary evidence and conclusions without any explanation. For example, he states (1, p. 380): ". . . there is no proof that the carbonate substitution takes place in scawtite." McConnell and Murdoch (5), on the other hand, supplied data from which they arrived at conclusions which are quite the opposite of those of Posner.

Elsewhere (1, p. 379) Posner says that x-ray diffraction intensity differences reported between fluorapatite and francolite (6) have been shown by him (7) and by Carlström (8) "to be due to orientation effects." Carlström, actually, was quoting Hendricks (9), who states (p. 186): "In my opinion, the principal reason that the sample of francolite gave this particular pattern was due to crystal orientation." (Italics added.) However, Hendricks' opinion does not coincide with the experimental data. For the (hk0) family of atomic planes, intensity measurements (automatically recorded with the North Am rican Philips apparatus) show that although most of the prismatic reflections are of greater intensity for francolite, this is not true for all of them. In the absence of any theoretical explanation of how the intensities could increase for certain (hk0) reflections without doing so for all of them, it must be concluded that these intensity differences are not caused solely by orientation effects but must be caused by compositional differences. Furthermore, it cannot be shown that the differences in the fundamental periodicities are in any way related to

orientation effects, so there must be compositional differences which are capable of producing intensity differences, whether these intensity differences are measurable or not. My measurements definitely show intensity differences which cannot be attributed to preferential orientation. Several persons have confirmed the differences in fundamental periodicities.

Numerous other minor matters are discussed by Posner, but a thorough denial of most of his arguments surely exceeds the scope of this communication. Elsewhere (2) a series of data and conclusions are presented which lead to general conclusions that are diametrically opposed to those of Posner. The present communication is intended to consider merely some of Posner's arguments which have not been adequately considered elsewhere, but which are, nevertheless, incompatible with both the experimental data and accepted theory.

DUNCAN McCONNELL

Health Center,

Ohio State University, Columbus

References

- A. S. Posner, chapter in Calcification in Biological Systems, R. F. Sognnaes, Ed. (AAAS, Washington, D.C., 1960).
 D. McConnell, Arch. Oral Biol., in press.
 D. McConnell, W. J. Frajola, D. W. Deamer, Science 133, 281 (1961).
 D. McConnell, Naturwissenschaften 47, 227 (1960).

- (1960). 5. D. McConnell and J. Murdoch, Am. Mineral-
- ogist 43, 498 (1958).

 6. D. McConnell, Trans. Macy Conf. on Metabolic Interrelations 4, 169 (1952). See also Bull. soc. franç. mineral. et crist. 75, 428
- (1952).
 7. A. S. Posner, unpublished thesis, Univ. of Liège, Belgium (1954).
- Liège, Belgium (1954).
 S. D. Carlström, Acta Radiol. Suppl. 121 (1955).
 S. B. Hendricks, Trans. Macy Conf. on Metabolic Interrelations 4, 185 (1952); see also

I welcome the opportunity to answer Duncan McConnell's comments on my review article entitled "The nature of the inorganic phase in calcified tissue" (1). McConnell objects to the concepts presented on carbonate-containing apatites and on the structure of various hydroxyapatites. His arguments will be dealt with in sequence.

The section of my article dealing with the carbonate problem was introduced with the statement, "The role of carbonate found in mineral tissue is still in debate." This treatment included references to both major viewpoints, (i) that the carbonate is substituted in the structure of apatite, and (ii) that carbonate is adsorbed, or ad-

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mixed as a separate phase. In my conclusion I expressed the "view," that is, the opinion, that the bulk of the data support the exclusion of carbonate as a structural constituent in apatite. I made it clear that further evidence must be collected before this viewpoint can be held to be incontrovertible.

The article by McConnell and Murdoch (2) does not contain crystallographic proof that the carbonate is a structural constituent of scawtite. Without a detailed x-ray diffraction structure analysis, or some equivalent quantitative method which can assign, with certainty, position parameters to the constituent atoms, any structure must remain in doubt. Even if it were proved that carbonate appears as a structural constituent of this silicate mineral (scawtite), this would not constitute proof that the same situation holds for the basic calcium phosphates, that is, the apatites.

Hendricks (3), Carlström (4), and I (5) have stated that the x-ray diffraction patterns of francolite and fluorapatite as shown by McConnell (6) are different in relative intensity values, owing to an orientation effect. McConnell kindly supplied me with some of the francolite used in his study (6). It was possible to produce an oriented powder diffraction pattern such as he shows, or, if proper precautions were taken to avoid orientation, it was possible to produce a pattern coincident with fluorapatite. This result was reported to McConnell in personal conversation before he submitted his paper (6) for publica-

It is not true that the x-ray diffraction studies on apatite discussed by McConnell were performed on materials which were not analyzed. The single-crystal, x-ray diffraction refinement of the structure of hydroxyapatite was performed on well characterized crystals prepared in our laboratory (7). In addition, each sample of the calcium-deficient hydroxyapatites was shown to be a single phase and was characterized by chemical and physical analyses (8). Reference to the original papers will corroborate this statement.

Whether or not carbonate must be present for physiological mineralization is not a subject treated in my chapter (1) and needs no further discussion here. It is possible, by taking special precautions, to prepare hydroxy-

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apatite free of all carbonate content. Thus the presence of carbonate is not needed for the synthesis of hydroxy-

The study of the exact nature of mineral tissue is fascinating work. There is room in this field for many viewpoints and dissenting theories. I think it is important to state clearly what is known and what is not known about these systems and I have attempted to do this in my chapter (1). I urge all workers in this field not to be satisfied with the half-answers in our possession now. We need more experiments, more facts, to define the atomic structure of hard tissue.

AARON S. POSNER

8408 Whitman Drive, Bethesda, Maryland

- A. S. Posner, chapter in Calcification in Biological Systems, R. F. Sognnaes, Ed. (AAAS, Washington, D.C., 1960).
 D. McConnell and J. Murdoch, Am. Mineralogist 43, 498 (1958).
 S. B. Hendricks, Trans. Macy Conf. on Metaster.

- S. B. Hendricks, Trans. Macy Conf. on Metabolic Interrelations 4, 185 (1952).
 D. Carlström, Acta Radiol. Suppl. 121 (1955).
 A. S. Posner, thesis, Univ. of Liège (1954).
 D. McConnell, Bull. soc. franç. mineral. et crist. 75, 428 (1952).
 A. S. Posner, A. Perloff, A. F. Diorio, Acta Cryst. 11, 308 (1958).
 A. S. Posner and A. Perloff, J. Research Natl. Bur. Standards 58, 279 (1957).

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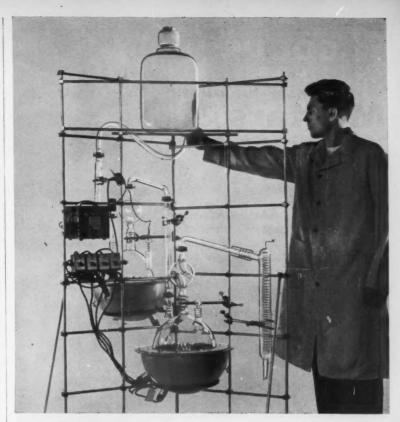
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The game of measuring past scientists against present grant-reviewing policies [Science 133, 1040 (1961)] can be played without end. Freud was never psychoanalyzed, Mendel lacked training in genetics, Boas's degrees were not in anthropology, and Faraday's formal qualifications were belittled in his own time.

But these pioneers are not the applicants for today's research dollars. The request for a \$20,000 analyzer rarely comes from an amateur in science, and the retired school teacher does not seek \$50,000 (plus overhead) for studies on carcinogens. Current applicants make a point of their education, degrees, training, publications (and imagination) and expect to be judged accordingly.

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STANLEY M. GARN Fels Research Institute, Yellow Springs, Ohio

Federal Aid to Education

In the editorial "Equal but separate," on federal aid to education [Science 133, 1043 (7 Apr. 1961)], there are several debatable points—for example, that of the legality under the constitution of federal aid to education and of whether the necessity for this is real (the increase in school construction since World War II has been much more rapid than the large increase in the number of students).

The point that really concerns me, however, is the argument that federal aid is needed because the communities and the property tax can no longer support schools. Does the author of the editorial feel that there are other sources, aside from all the local communities, of federal income, and does he feel that the money the federal government acquires in a community multiplies on its trip to Washington? If this type of fuzzy thinking is representative of the scientific community which Science represents, the situation is indeed deplorable.

RALPH S. RIFFENBURGH 595 East Colorado Boulevard, Pasadena, California

The editorial entitled "Equal but separate" contains errors in logic and fails to use facts to justify a position. It is, therefore, little more than a regurgitation of some widely publicized views. Such a spurious effort is especially inappropriate for a scholarly publication.

For instance, it is a flagrant non sequitur to claim "the deficiencies in education in the United States are serious in the extreme" follows from

p

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"... the U.S. Office of Education puts the need at around 140,000 new classrooms, with no expectation that the property tax, the present mainstay of school financing, can even begin to meet this need."

Moreover, the author of the editorial conveniently fails to note that the Office of Education booklet No. OE-10005 also shows, in Table 6, that the "need" for new classrooms declined from something in excess of 159,800 to 132,400 during the period 1955 through 1960. Nor does he mention that the number of graduates per 100 persons 17 years of age has risen steadily to 64.9; that the percentage of the population that is illiterate has fallen steadily to 2.2; that the pupilteacher ratio has fallen to 25.8 to 1: that the number of pupils in excess of normal capacity has declined 17.3 percent in the last five years; that the total number of degrees earned has steadily risen, to a level of 486,400 in 1960; that total expenditures per pupil for public elementary and secondary schools has steadily risen, to \$446; that total expenditures for education, as a percentage of national income, now stands at 5.39 percent. These data preclude any belief that "deficiencies in education in the United States are serious in the extreme." If present "deficiencies are serious in the extreme." educational conditions heretofore would have to be described as chaotic: I think most of us, including the author of the editorial, would be reluctant to draw such a conclusion.

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In addition, even the author's basic premise is faulty! The property-tax structure certainly is capable of being increased considerably; property taxes are on the rise and have been for many years. Furthermore, there are other state, county, city, and miscellaneous local sources of tax revenue untapped as yet. Is it too much to ask that editorial writers recognize that federal funds for education arise from the same sources as do local funds for education?

Consider for a moment that in 1940 the size of the U.S. economy, measured by gross national product, was \$100 billion; today it is \$500 billion. In 1940 the federal government was getting from taxes about \$5 billion, or 5 percent of the nation's economic wealth. It is now getting \$80 billion, or 16 percent of the economic wealth. I submit that the federal government, not local government, has reached the point of diminishing returns on tax

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yield. What magic spell will the federal government weave to create greater support for education? And where is the evidence validating the real need for federal support on an expanded scale?

The editorial seems to imply justification for federal aid to education by saying, "One of the bitter truths about education is that opportunities are not equal for all students. Difference in level of income is a familiar source of inequality." But, here again, the editorial fails to recognize that differences in intelligence, in physical stamina, and in parents also are familiar factors intimately related to inequality of opportunity for education. The really perti-

nent question is whether true equality of opportunity for education can ever be attained while the noneconomic, human factors determining an individual's level of income remain unequal. Indeed, singling out income as a variable appropriation for federal subvention is specious reasoning.

Is it, in fact, a "bitter truth" that opportunities for education are not equal for all students, as is claimed by the author of the editorial? Perhaps my thinking is conditioned by the fact that I was able to earn advanced degrees from a state-supported university (Illinois) and a private university (Chicago) with absolutely no parental or scholarship financing. I do believe

a good case can be made for the value of overcoming obstacles in obtaining an education. At all events, the "opportunity" to work one's way through school still exists, regardless of the merits of the procedure! Moreover, there are today far more student "opportunities" for scholarship and loan assistance than was true just a few years ago. We surely recognize, do we not, that rapidly rising personal incomes are ever more widely distributed among the population and are powerful equalizers of opportunity for higher education? Greater equality of opportunity now exists regardless of the parent's absolute level of income. Last, but by no means least, the Conant report shows clearly there is no difference in the quality of secondary education obtained by students attending the "better" schools-that is, those with greater financial resources. One must conclude that the advantage supposedly accruing to the more affluent parent is illusory. A valid summation of educational opportunities is that they are more widespread than ever before; the only "bitter truth" is that for certain people it is "easy" to obtain an education.

For the past 185 years we have had an expanding educational system that makes education increasingly available. Ever more students, in total and on a per capita basis, take advantage of these benefits. Our educational system has evolved with minimal federal aid (3.5 percent of the total financial support of primary and secondary education.) Rather, massive local aid to education has made our educational progress possible. I submit that we are quite capable of improving and extending this system without the alleged panacea of federal aid for public school construction and teachers' salaries.

May I suggest that in the future the editors of *Science* editorialize on matters of natural science, not sociology. Readers are more willing to accept your competence here, and your editorials are apt to be valid.

E. H. VAUSE Foundation,

Charles F. Kettering Foundation, Hinsdale, Illinois

These communications offer many criticisms. In reply, I should like to offer two reasons why the old reliable property tax as a source of funds for schools is of limited use. (i) The distribution of children through the country is not well correlated with the dis-





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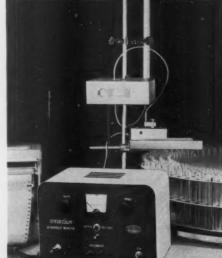
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tribution of valuable property. On a variety of scales, from city versus suburbs to this region of the country versus that region, the children are one place and the money is another. (ii) The property tax is very regressive. According to testimony by the National Education Association in support of federal aid to education, "this tax hits incomes under \$2000 almost three times as hard, percentagewise, as it does the incomes of \$15,000 and over."

I am not pretending that these arguments are original. As Vause says, the views expressed in the editorial are "widely publicized." I am merely suggesting that these views, if well known, have also been well defended.—J.T.

Satellite Orbits

I. I. Shapiro and H. M. Jones, of the Lincoln Laboratories, and R. W. Parkinson, their collaborator, now at Aeronutronics Inc., have raised the question of priority with respect to the publication of calculations on the effect of radiation pressure on satellite orbits.

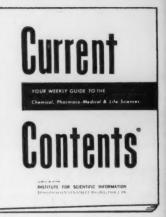
I am more than pleased to put on record the fact that our interest in this subject was stimulated by reports of the work of Shapiro, Parkinson, and Jones, which they subsequently published [Science 131, 920 (1960)]. These reports led me to suggest to Peter Musen of our division that he might undertake an investigation of this same problem. As a result of my suggestion Musen developed an independent theory of the effect of radiation pressure on satellite orbits, which he and his collaborators applied shortly thereafter to the orbit of the Vanguard satellite [Musen, Bryant, and Bailie, Science 131, 935 (1960)], demonstrating that the discrepancy between theory and observation for the Vanguard orbit was removed by the allowance for this effect.

ROBERT JASTROW Theoretical Division, National Aeronautics and Space Administration, Silver Spring, Maryland

Aims of a Scientists' Association

Theodore C. Kahn's letter of resignation and protest [Science 133, 656 (3 Mar. 1961)] will undoubtedly bring many responses. I think that I am with the majority of members of the AAAS in believing that our association is not

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designed for the economic advancement of scientists. I do agree that the economic and social position of physicians is to be envied, but I do not attribute that to the American Medical Association.

The AMA has accomplished a great deal for the science of medicine and for the standards of medical education and medical practice. But I'm amazed that Kahn should wish to have the AAAS emulate the accomplishments of the AMA for the economic and political situation of its members. I thought it was pretty generally agreed that physicians manage their personal relationships very much better than their coordinated public relations. Many of us think that the resourcefulness of AMA is inadequate to the demands of our rapidly changing culture. Understand, I'm not writing about the shortcomings of AMA-of course I wish we physicians knew better what to do. I am only trying to make clear how fatuous is Kahn's expressed desire for a scientists' association that will engineer scientists' success.

R. R. NEWELL

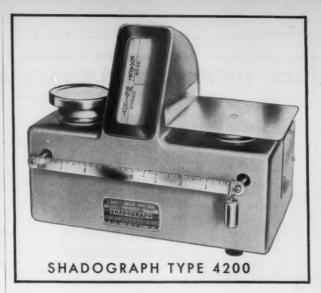
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"Xenobiology"

The nominalistic problem of a generic prefix for the sciences concerned with the study of extraterrestrial autocthons had been faced, and elegantly solved, by at least one science-fiction author long before it had become the putatively realistic concern of such august bodies as the National Academy of Sciences-National Research Council. The proper word, as any science-fiction reader should know, for the study of, say, extraterrestrial biology is "xenobiology," not "exobiology." This neoterism was used by Robert Heinlein some 7 years ago. His arguments in favor of it are set forth in the following personal letter.

You are correct in thinking that I used "xenobiology" (and several other words starting with "xeno-" in *The Star Beast* [Scribner's, New York, 1954]. But I am not certain that I coined the term; it is quite possible that I saw it used elsewhere, in fiction or non-fiction, and made use of it.

Of the several "xeno-" words I have used, I did coin "xenic," and this is a most useful adjective for designating anything foreign to the planet Earth—cultures, life forms, customs, history, clothing, food, you name it.



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.I note that Hubertus Strughold uses "astrobiology" in the way in which Lederberg [Science 132, 393 (1960)] uses "exobiology" (and as you and I use "xenobiology"). Try coining a designating adjective from either of these terms: "astral" and "exic" seem to be the obvious ones. "Astral" is not only tainted with occultism, but is off in the wrong direction to start with, as "astron" is a star—and stars are about the least likely places to find life, culture, etc.

"Exobiology" does not suffer from the innate self-contradiction found in "astrobiology" but the prefix "ex-" or "exo-" has its own great shortcomings; it is tired and means too many things. The Merriam unabridged lists some 200 "ex-" words, and among them are many of the commonest words in English. . . . But "xeno-" and "xen-" have only seventy entries not one of which is a common

word.

I submit that it is more sensible to use this almost-virgin prefix in designating non-terrestrial things, concepts, and fields of study as it will minimize conflicts in meaning, since a neologism constructed with the prefix "xeno-" is extremely unlikely to resemble or duplicate any other word already in existence (I can find only two probables; "xeno-parasite" and "xenolith"—see p. 2963 of the big Merriam).

But the situation is quite different with "ex-" and "exo-"; there are hundreds of probable conflicts with common words; e.g., a major field in "exobiology" is necessarily "exogenetics"—but exogenetic already has an established meaning in biology. A scanning of pp. 887-904 of Merriam will disclose dozens to hundreds

of such conflicts.

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In my opinion, "xeno-" is the best choice from the standpoint of derivation. But, be that as it may, it is certainly the best of these three in the interest of clarity and exactness.

ROBERT HEINLEIN
Colorado Springs, Colorado

I submit that Heinlein has set forth the arguments for "xenic," "xeno-," and "xen-"; let not xenophobia stand in the way of the prompt adoption of these useful, elegant, and unique prefixes for designating the extraterrestrial sciences.

HAROLD WOOSTER

2108 Seminary Road, Silver Spring, Maryland

Exporting Universities

In response to the editorial "Diploma diplomacy" [Science 133, 1557 (19 May 1961)], I wish to second the motion of Arthur F. Burns that universities be exported to those countries that ask for educational aid.

It has been my observation that edu-

cation in the United States of foreign students brings much dissatisfaction to the individual himself upon his return to his native land. This is due to the fact that facilities which he has become acquainted with in the United States are not available to him in his homeland, and therefore he has little opportunity to teach others what he has learned. With the exporting of a university, the facilities would be established in his own country and would always be available to him, even after graduation.

The exchange of graduate students from foreign countries is healthy and good at the level of the individual, but for real upgrading of a country's education the educational facilities should be built on the students' own soil and the degrees given should include graduate degrees requiring research.

Having been an engineering adviser at Cheng Kung University in Taiwan for two years, I wish to put in a word of caution regarding foreign aid to education. Education does not adapt itself too well to crash programming. At least 10 years are needed, with a tapering-off period of 5 years during which both financial aid and advisory aid are gradually diminished to zero.

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 Wood, F. C., Gurin, S., and Kuo, P. T.: Medical Correlation Clinic on Atherosclerosis and Coronary Artery Disease, Am. Pract.-Dig. Treat. 12:235 (April) 1961.

 Heiskell, C. L., Fisk, R. T., Florsheim, W. H., Yachi, A., Goodman, J. R., and Carpenter, C. M.: A Simple Method for Quantitation of Serum Beta-Lipoproteins by Means of the Immunocrit, Amer. J. Clin. Path. 35:222 (March) 1961.

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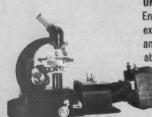
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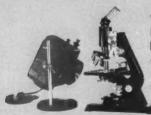
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Rubidium frequency standard uses an optically pumped rubidium-87 cell as the basic frequency reference. Optical pumping to redistribute the atoms among the energy states of rubidium is effected by irradiating the cell with light from a rubidium-85 vapor discharge lamp excited to luminescence by a radio-frequency field supplied by a transistorized oscillator. When the cell is irradiated by microwave energy of proper frequency, the energy levels depleted by optical pumping tend to be replenished by a further redistribution of the atomic energy states. As a result, more pumping energy is absorbed. When the microwave energy is at the precisely correct frequency, the transmission of pumping light is at a minimum. This minimum is detected by a photodetector from which an error signal is derived that is used to maintain the microwave frequency. In the instrument, microwave energy is generated by a crystal oscillator at 6834 Mcy/sec, the resonant frequency of rubidium-87, and is supplied to a resonant cavity containing the gas cell. The stabilized signal from the crystal oscillator is fed to a transistorized frequency synthesizer circuit that provides three output frequencies: 5 Mcy/sec, 1 Mcy/ sec, and 100 kcy/sec. Output power is 10 mw into a 50-ohm load. (Space Technology Laboratories, Inc., 8929 Sepulveda Blvd., Los Angeles, Calif.)

Circle 1 on Readers' Service card

Teaching microscopes, series 60, include a selection of models ranging from instruments specifically designed for teaching high school biology and botany to others more elaborately equipped for intermediate and advanced course work. In these microscopes, the

traditional rack and pinion focusing system has been eliminated; the nose-piece assembly itself can be focused. Built-in slide protection is afforded by spring-loaded construction of the nose-piece assembly and by a variable autofocus stop. (American Optical Co., Buffalo 15, N.Y.)

Circle 2 on Readers' Service card

High-vacuum laboratory enclosure (Fig. 1) is available in standard units of 4- by 5-ft modules and in special sizes. The units are constructed with 12-in. diameter glass viewing ports mounted in a sloping front, a 15-in. diameter airlock, and a rear access panel measuring 12 by 18 in. Bellowstype neoprene gloves permit manipulation in the interior. The units are fabricated of ½-in. stainless steel plate. Glass viewing ports are 1-in. thick polished plate glass. (S. Blickman, Inc., 536 Gregory Ave., Weehawken, N.J.)

Circle 3 on Readers' Service card

Airborne-particle monitor is modified by the addition of an air-dilution system to cover the range from cleanroom atmospheres to the most polluted industrial smogs. The dilution system provides a continuously variable addition of filtered dilution air (from 0 to 200 cm³/min) to a basic sample, giving dilution ratios up to 50:1. The basic facilities of the monitor can be used with or without the dilution system. Fifteen subranges of particle size from 0.32 to 8µ can be examined and individually indicated on decade registers and recorded by galvanometer, potentiometer, or digital printer. Particle concentrations up to 7340 per minute can be counted with the normal 100-cm³/ min sample input. Manual selection or automatic scanning of particle-size ranges can be chosen; in the programmed mode of operation the instrument allows for 0.3, 1, 3, or 10 min of monitoring at each range. (Royco Instruments, Inc., 440 Olive St., Palo Alto, Calif.)

Circle 4 on Readers' Service card

Decade counter tube (Fig. 2) is a cold-cathode, gas-filled tube which provides an output pulse said to be of sufficient magnitude so that an interstage coupling amplifier is not needed. The tube operates at counting rates up to 4 kcy/sec. Indication is made by an orange-red glow discharge that is viewed through the dome of the tube envelope at the end of the electrodes. (Amperex Electronic Corp., 230 Duffy Ave., Hicksville, N.Y.)

Circle 5 on Readers' Service card

Residual-gas analyzer for continuous analysis of residual gases in a vacuum system utilizes the mass-spectrometer principle. The instrument is composed of a mass analyzer with a magnet and d-c amplifier and control circuits. Capabilities are said to include resolving power sufficient to separate adjacent peaks up to mass 20 and ability to measure quantities of gas and vapors at mass-to-charge ratios ranging from 2 to 80. Sensitivity is said to be sufficient to permit analysis of gases in the pressure range 10⁻¹ to 10⁻⁰ mm-Hg. Continuous identification of mass un-



Fig. 1. High-vacuum laboratory enclosure.



Fig. 2. Decade counter tube.

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science nor the writer assumes responsibility for the accuracy of the information. A Readers' Service card for use in mailing inquiries concerning the items listed is included on pages 139 and 221. Circle the department number of the items in which you are interested on this card,

21 JULY 1961

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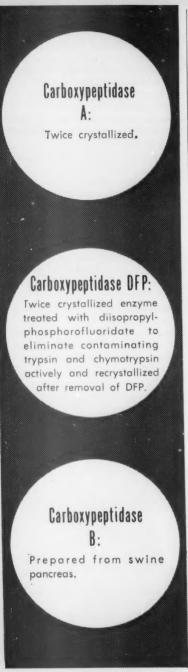
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VOL. 134



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der analysis is provided by a self-adjusting central control function that can be manually advanced or turned back for selective analysis of specific peaks. It also permits the instrument to be preset to start or stop at any point on the spectrum. A programmer accessory is available to attenuate and control the scan of a preselected series of masses. Power input requirement is 3 amp, 105 to 125 volts, and 60 cv/sec; variations of 5 volts are tolerated; bakeput temperatures up to 450°C can be used. (Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena. Calif.)

Circle 6 on Readers' Service card

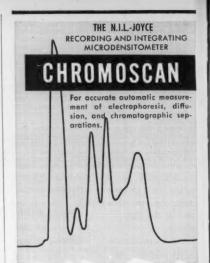
Torque meter is a dynamometer that is slipped onto the shaft and held by a hand-tightened collet. Interchangeable collets fit a wide range of shaft sizes. Torque up to 22 in. Ib is measured in either direction. Transmitted torque is read from the dynamometer dial by means of a stroboscopic illuminator; rate of rotation is read from the stroboscope dial. Accuracy is said to be ±0.5 percent. (Micro Pump Corp., Box 392, Danville, Calif.)

Circle 7 on Readers' Service card

Differential current meter measures the current from two transducers separately or differentially. Dynamic range of the instrument is 10^{a} ; it will measure current of 10^{-a} amp full scale. Frequency response is 0.5 cy/sec at the lowest range increasing to 30 kcy/sec at the least sensitive range. Preamplifiers with a gain of 10^{a} are available for low level measurements. (Eldorado Electronics, 2821 10 St., Berkeley 10, Calif.)

Circle 8 on Readers' Service card

Chromatographic system for closedloop control of processes delivers control signals of 0 to 4 ma, 0 to 50 volts, proportional to the concentrations of measured components. A current-to-pressure transducer may be used to adapt the instrument to pneumatic-control systems. The system incorporates a sensing unit and a multicomponent peak-reading controller. A high-speed pneumatic valve in the sensing unit introduces gas samples into the chromatographic column in less than 1 sec. Carrier gas flow rate and analyzer temperature are controlled. Sensing unit functions are controlled and actuated by a programmer. A memory and transmission unit receives, selects, and stores peak values of the component signals transmitted



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21 J

Electrophoresis of human serum on cellulose acetate carried out with the N.I.L.-Agafor Micro and Immuno Electrophoresis Apparatus, Running time 30 minutes, Trace was repeated 5 times to show perfect reproducibility of Chromoscan.



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- Interchangeable rectangular slits and circular apertures from 0.01 mm to 3 mm.
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* Send for BULLETIN 264 for complete description.

NATIONAL INSTRUMENT LABORATORIES, Inc. 828 Everts St., N.E., Washington 18, D. C. Tel. NOrth 7-7582 and later amplifies and transmits segregated peak values according to commands from the programmer. The transmitted signals are available for both control and data-recording purposes. (Perkin-Elmer Corp., Norwalk, Conn.)

Circle 9 on Readers' Service card

X-ray diffractometer attachment for the study of powder, wire, or sheet specimens at high temperature in high vacuum, consists of two major partsa completely removable water-cooled jacket and a base plate with furnace stand and platinum specimen mount. The specimen's position may be adjusted during the run, without disturbing the vacuum or temperature conditions, by two rotational controls and one translational control located outside the instrument. The furnace elements of 40percent rhodium platinum permit operation in air at elevated temperatures. Xrays enter and leave the attachment through two beryllium windows that permit reflection from 0 to 160 deg. Models are available for the Norelco wide-range diffractometer, the GE spectrogoniometer, and the RCA horizontal diffractometer. (MRC Manufacturing Corp., 47 Buena Vista Ave., Yonkers, N.Y.)

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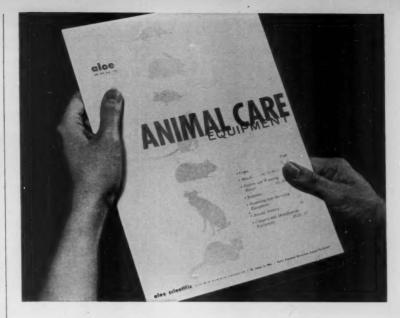
Circle 10 on Readers' Service card

Time delay is continuously variable up to 3 nsec by manual adjustment or by motor with push-button switch. Bandwidth is from d-c to more than 2000 Mcy/sec. Specifications quoted by the manufacturer include: accuracy better than ±1 percent at any point with calibration capability to ±0.01 percent; resolution time infinitesimal and readability better than 0.05 psec; input voltage greater than 500 peak volts; maximum attenuation 0.017 db at 100 Mcy/sec, 0.68 db at 1000 Mcy/sec, and 0.85 db at 1500 Mcy/sec. The instrument is coaxially constructed and consists of bilateral passive network with no active devices. (Ad-Yu Electronics Laboratory, Inc., 249-259 Terhune Ave., Passaic, N.J.)

Circle 11 on Readers' Service card

512-Channel analyzer, model ND 120, is based on the manufacturer's model ND 102, 256-channel analyzer with various circuit improvements. The unit has 10° count capacity and is rack mounted; the circuitry is said to be extremely accessible. (Nuclear Data, Inc., 3833 W. Beltline, Madison, Wis.)

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Fig. 3. Magnetic-core memory.

Magnetic-core memory (Fig. 3) operates at 1 Mcy/sec with access time of 0.4 μ sec. Two standard sizes are available, 128 and 512 words, with 24 bits per word. No rewrite circuitry is needed for the nondestructive memory. Loading can be performed at speeds up to 200 kcy/sec, if desired, but the standard input is from paper tape. Ambient temperature range for operation is 0° to 50°C; power consumption is 50 watts for the 512-word memory. (Aeronutronic Division, Ford Motor Co., Ford Rd., Newport Beach, Calif.)

Circle 13 on Readers' Service card

Timing modules may be used as completely self-contained, sold-state, timedelay devices offering single-pole normally open output, or they may be used to operate a separate magnetic relay. In operation negative d-c appears at load terminals after continuous energization for specified delay intervals and remains until supply is interrupted. Operating voltage range is 24 to 30 v d-c; operating temperature range is -55° to +100°C; time tolerance over the specified operating range is said to be ±10 percent. Delay ranges are factory set between 0.1 and 30 sec in two models and between 30 and 60 sec in a third model. Reset to 90-percent recovery is achieved in 0.2 or 1 sec depending on the model. (G-V Controls Inc., Okner Parkway, Livingston, N.J.)

Circle 14 on Readers' Service card

Scanning monitor oversees as many as 200 inputs that can be represented by a d-c voltage as low as 10 mv full scale. Display lights indicate out-of-limits conditions; also, a warning horn, which can be silenced by an acknowledgment button, sounds. Scanning rate is five points per second; limits are in-



Fig. 4. Static voltmeter.

dividually set by inserting pins in a pinboard. Accuracy is said to be ±0.1 percent of full scale. Manual readout of any point with ±1-percent accuracy is available continuously. At 2-sec intervals the system selects the point addressed for manual readout and applies its signal to the readout meter. The reading is held by the meter for 2 sec during which the normal scanning of the monitor continues. Point identification is continuously displayed in lighted numbers. Self-checking devices are incorporated to verify operation of the detecting amplifier, alarm circuit, and indicating lights and continuity of input circuits and input selection relays. Each check requires 30 sec and may be repeated as frequently as desired. (Hagan Chemicals and Controls, Inc., Hagan Center, Pittsburgh 30, Pa.)

Circle 15 on Readers' Service card

Static voltmeter (Fig. 4), manufactured by Rothschild of Zurich, measures static charges from 0 to 5000 volts in eight ranges. A probe electrode permits direct measurement of potential on the surface of material. A synchronous motor discharges the static voltage to ground every 5 sec to permit the slope of the charge to be determined independently of the equilibrium voltage. Surface conductivity up to 10¹⁵ ohms is measured by a special electrode that measures the half value of an input voltage. (Fabrionics Corp., P.O. Box 521, Huntington, N.Y.)

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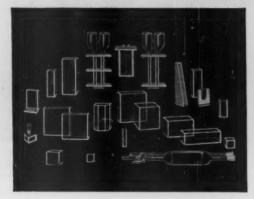
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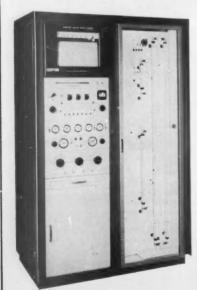
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PHOENIX PRECISION INSTRUMENT COMPANY 3803-05 NORTH FIFTH ST., PHILADELPHIA 40, PENNSYLVANIA 34-in. diameter, semicircular ingot form and weigh about 20 g/in. Mobility and resistivity data are supplied with all single-crystal material. Measurements are made on an untrasonically formed Hall sample from material immediately adjacent to that supplied. (Micro State Electronics Corp., 152 Floral Ave., Murray Hill, N.J.)

Circle 17 on Readers' Service card

Rubber tubing lined with polytetrafluoroethylene plastic combines the advantages of chemical inertness of the liner with desirable mechanical properties of the rubber tubing. The liner is available with internal diameters from ½ to 1 in. covered with ½-in. neoprene rubber or other elastomer. (Pennsylvania Fluorocarbon Co., 1115 N. 38 St., Philadelphia 4, Pa.)

Circle 18 on Readers' Service card

Pulverizer for preparation of samples for spectrochemical analysis achieves uniformity of particle size by the use of screens and an air stream to remove particles from the grinding chamber as soon as they reach a predetermined size, while grinding is going on. Coarse material, up to 3/16 in, in diameter, is fed into a grinding chamber that is shaken by an eccentric mechanism. An air stream directed through the chamber is reversed in direction 200 times per minute. The reversal of the air path cleans the screens while removing the particles to a collector. Screens as fine as 450 mesh are available. (Pitchford Scientific Instruments Corp., 501 Castle Shannon Blvd., Pittsburgh 34, Pa.)

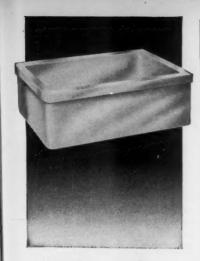
Circle 19 on Readers' Service card

Air monitor is designed to detect radiation in airborne iodine vapor. It detects and records specific gamma activity in the energy range 0.33 to 0.55 Mev and warns of alarm conditions. The unit can also be set for other energy ranges. In operation, vapors are deposited on an activated carbon filter, and iodine activity in the deposit is recorded. (Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.)

Circle 20 on Readers' Service card

Pulse generating equipment features high repetition rates and fast rise and fall times. Available are two clockpulse generators and a programmed pulse generator. The clock-pulse generators include a 3- to 25-Mcy/sec unit and a 25- to 100-Mcy/sec unit

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with appropriate overlap. Rise and fall time of the clock pulses is less than 4 nsec; pulse width is less than 8 nsec at half pulse height; amplitude is continuously variable from 0 to 4 volts; output impedance is 93 ohms. The programmed pulse generator features internal pulse repetition rate, 3 to 25 Mcy/sec; rise and fall time, less than 6 nsec; amplitude, 0 to 5 volts; output impedance, 93 ohms. Ten pulse times are provided, with front-panel control for selecting any combination of these pulse times individually for each output. Up to four independent outputs can be provided. (Texas Instruments Inc., P.O. Box 6027, Houston 6, Tex.)

Circle 21 on Readers' Service card

O-ring slide chart for metal O-rings covers ring diameters of 0.25 to 50 in. and includes specifications for plain, plated, and coated rings. When the slide rule is set at the nominal outside diameter of a standard ring, the proper installation dimensions are found. For nonstandard rings, the chart gives data for the calculation of installation dimensions. Charts can be obtained by request on company letterhead. (Advanced Products Co., 59 Broadway, North Haven, Conn.)

Circle 22 on Readers' Service card

Level recorder is a high-speed graphic recording voltmeter for measuring r.m.s., average, or peak level of a-c signals from 10 to 200 kcy/sec or, through an internal chopper, d-c to 10 cy/sec. The recorder operates as a nullbalancing electromechanical servo with six linear or logarithmic recording ranges from 10 to 75 db. (B & K Instruments, Inc., 3044 W. 106 St., Cleveland 11, Ohio)

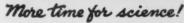
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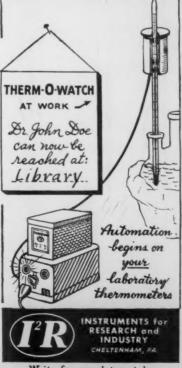
Vacuum gage of the cold-cathode ionization type measures over the range 10-1 to 10-0 mm-Hg. The gage is designed for convenient disposal and replacement of dirty or contaminated anode and cathode. The control circuit includes a rectified high-voltage supply and a potentiometer for compensation of line voltage variations. Indication is provided by a 4-in. meter. (Temperature Engineering Corp., Riverton, N.J.)

Circle 24 on Readers' Service card

Temperature transducer covers the temperature range -320° to +280°F. The transducer functions as one arm of a four-arm bridge. Excitation current is







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Circle 25 on Readers' Service card

Vacuum recorder is a miniature instrument measuring 3% in. by 5% in. high. Two ranges, 0 to $1000~\mu$ -Hg and 0 to 20 mm-Hg, are available. The instrument uses compensated vacuum thermopile circuitry. Recording is accomplished by clamping bar action on pressure-sensitive chart paper. Scales are calibrated directly in absolute pressure units. One roll of chart paper is used during 15 days of operation. (Hastings-Raydist Inc., Hampton, Va.)

Circle 26 on Readers' Service card

Voltage-reference source is a four-decade, direct-reading device with full-scale output of ±111.11 volts which can be selected in 10-mv increments. Resolution is 1 part in 10,000 plus vernier, and accuracy is said to be ±0.025 percent at 25°C with temperature coefficient 0.002 percent per degree centigrade. Output impedance is less than 0.1 ohm. The instrument is not harmed by short circuit. (Electronic Development Corp., 423 W. Broadway, Boston 27, Mass.)

Circle 27 on Readers' Service card

Alpha-numeric display module can display 64 individual characters when operated from a six-bit binary input or 16 characters when operated from a four-bit binary input. The device will change from one character to another within a maximum time of 50 msec. Characters are held on display without any drain on the command input circuit. Characters measure ½ in. high by 5/16 in. wide; the module measures 4½ by 1-3/16 by 1 in. (Servomechanisms, Inc., 200 N. Aviation Blvd., El Segundo, Calif.)

Circle 28 on Readers' Service card

Power supply designed for instrument calibration applications furnishes a-c and d-c power over the range 0 to 1500 volts, 0 to 30 amp, and 50 cy to 20 kcy/sec. Fixed-frequency settings of 50, 60, 400, 800, 1000, 1600, and 2400 cy/sec are also furnished. Accuracy is



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Bernhardt, H., Young, J. M., and Gourley, R. D. Cancer Vol. 13, No. 3, May-June 1960

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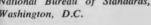
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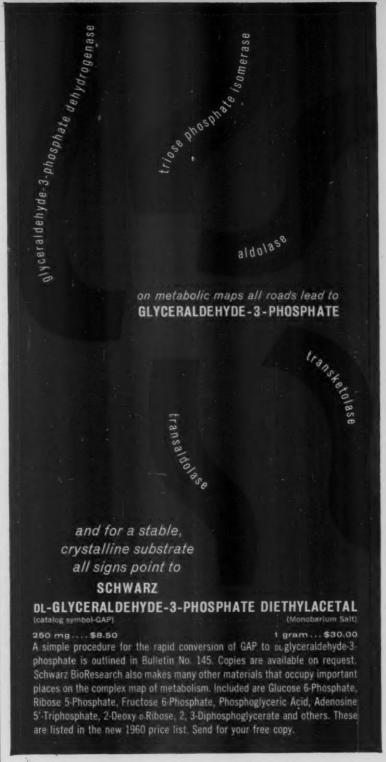
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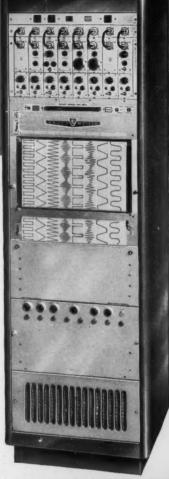
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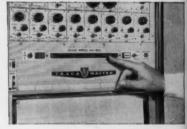




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